SCIENCE ABSTRACTS.

Section A.—PHYSICS.

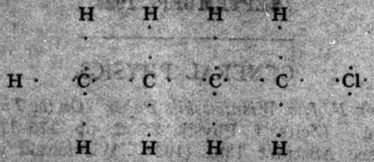
SEPTEMBER 1924.

GENERAL PHYSICS.

2198. *Note on F. J. v. Wisniewski's Paper "On the Theory of Helium."* **W. Heisenberg.** (Zeits. f. Physik. 25. 2. pp. 175–176, 1924.)—In a recent paper (see Abstract 1381 (1924)] Wisniewski investigated the problem of the excited helium atom in a new way, and asserted that, contrary to the work of Epstein, Landé, Bohr, v. Vleck, Born and Heisenberg, and Halpern, the correct term values for the parhelium spectrum can be obtained by application of existing principles of mechanics and quantum theory. It is clear from the outset that Wisniewski's mode of treatment must be based on a non-mechanical assumption, unless the concordant results of previous workers are accidental or contain the same error, and this is now found to lie in the circumstance that although the effect of the inner upon the outer electrons has been considered by Wisniewski, the reciprocal action of the outer upon the inner has not been taken into account. One result among others is that the total impulse of the atom is not constant. Even if Wisniewski's assertion be correct, his calculations afford no explanation of the presence and non-combination of the two spectra par- and ortho-helium, and the choice of quantum numbers and their arrangement appear very arbitrary. The author takes the opportunity to correct an arithmetical error in a previous paper [see Abstract 2364 (1923)], a factor $-15/8$ being replaced by $-\{15 + 27[2(2-1)]\}/8$ in the last term of equation (14). This produces a quantitative but not a qualitative change in the particular data discussed.

H. H. Ho.

2199. *Induced Alternate Polarities in a Carbon Chain on the Basis of Bohr's Theory.* **K. Højendahl.** (Chem. Soc., J. 125. pp. 1381–1388, June, 1924.)—The author explains, with the help of diagrams representing in the plane of the paper the relations assumed between the electron orbits, the case of chlorine bound to a long paraffin chain. In reality the orbits are arranged in space, and are probably not plane themselves. In agreement with the accepted view, the non-polar, covalent bond is regarded as consisting of two electrons revolving in orbits perpendicular to one another, each orbit having the form of an 8, with one of the atoms in each loop. When the atoms are unlike, the time intervals during which the electrons are in the neighbourhood of the respective atoms are unlike, the loops being unequal in size; the frequency condition of Sidgwick and the symmetry condition of Fowler are assumed to hold. It is shown that the terms positive and negative applied to atoms in an organic molecule correspond to small and large loops respectively. An attempt is made to estimate quantitatively the way in which the stress due to the Cl atom varies from carbon atom to carbon atom through the chain. The case of the benzene molecule is considered, numerically the alternating polarity effect persists round the entire ring; numerical values of the extent and sign of the polarity are attributed to the ortho-, meta- and para-positions. A slight modification of the conventional representation of the Lewis configuration is suggested to represent the application of the Bohr concepts to covalent bonds. The following is the representation of the chlorine compound already considered:—



$$\begin{array}{cccccccccc} & & H & & H & & H & & H & \\ & & \cdot & & \cdot & & \cdot & & \cdot & \\ & & & & \cdot & & & & \cdot & \\ H & \cdot & \cdot C \cdot & & \cdot C \cdot & & \cdot C \cdot & & \cdot C \cdot & \cdot Cl \cdot \\ & & & & \cdot & & & & \cdot & \\ & & \cdot & & \cdot & & \cdot & & \cdot & \\ & & H & & H & & H & & H & \end{array}$$

This indicates that the orbit loops of the four L electrons round the carbon atom to which the Cl is attached are larger than those of the next, and so on alternately. H. N. A.

2200. *On the General Definition of the Correspondence between Wave and Motion.* **L. de Broglie.** (Comptes Rendus, 179. pp. 39–40, July 7, 1924.)—The author has shown in previous papers [see Abstracts 256, 257, 576 and 1156 (1924)] that an interesting view-point of quanta phenomena is obtained by assuming that to the motion of every material point there is connected the propagation of a plane-wave whose frequency V is the quotient of the total energy E by the Planck constant h. This is not satisfactory from the relativity standpoint, since expression should be *via* relations between universal tensors and the author now seeks to define the correspondence between wave and motion from the latter standpoint. He takes for the characteristic wave tensor, the product of h and the energy-quantity tensor of motion. This leads to $E = h\nu$, and $G_r = h\nu/V_r = E/V_r$, where G_r and V_r are respectively the motion along the tangent to the trajectory and the speed of wave-phase in this direction. The second expression has for immediate consequence the identity of the principles of Maupertius and Fermat and the interpretation of the Bohr conditions as those of resonance. Generally, the speed ν of motion along the trajectory is at each instant equal to the speed of group V_r of wave-phases in this direction. The equation $G_r = h\nu/V_r$ is in accord with Brillouin's condition, whereby the motion of the quantum is always equal to its energy $h\nu$ divided by the phase-speed; then the laws of reflection and refraction can be deduced by application of the Maupertius principle to the light quanta. H. H. Ho.

2201. *The Propagation of Gravitation.* **E. Anding.** (Phys. Zeits. 25, pp. 183–187, May 15, 1924.)—A finite velocity of propagation of gravitation would have no influence upon the perihelion movement. On the other hand, however great it may be, it would bring about secular changes in the eccentricity distinctly at variance with experience. A. D.

2202. *Relativity.* **K. Bohlin.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. 1. pp. 1–12, 1924. In German.)—Let the transformation formulæ be $x' = k(x - vt)$ and $t' = k[t - (vx/c^2)]$; then, on importing the condition of reversibility, we must have $x = k(x' + vt')$, $t = k[t' + (vx'/c^2)]$. From these four equations, $k^2 = (1 - \beta^2)^{-1}$, where $\beta = v/c$. From the four equations, with $x = ct$ or with $x' = ct'$, we have $x' = x \,.\, k(1 - \beta)$, $t' = t \,.\, k(1 - \beta)$.—In vibrations, the frequency ν, is proportional to the unit of time; $\nu' : \nu :: t' : t$; $\nu' = \nu \,.\, t'/t = \nu \,.\, k(1 - \beta)$; and on passing from one unit of time to the other, $\Delta\nu/\nu, = (\nu' - \nu)/\nu, = k(1 - \beta) - 1$, $= -\beta + \frac{1}{2}\beta^2 - \ldots$. Approximately $\Delta\nu/\nu = -\beta$, or $\Delta\lambda/\lambda = \beta$, which at once gives Döppler's Law.—As to aberration, it is difficult to form a clear picture, but all comes right under relativity. Einstein assumes that the two light-vectors are the same, these being:—

$$\sin \nu\left(t - \frac{lx + my + nz}{c}\right), \quad \sin \nu'\left(t' - \frac{l'x' + m'y' + n'z'}{c}\right)$$

Of these, the former, on the application of the transformations $x = k(x' + vt')$, $t = k[t' + (vx'/c^2)]$ becomes

$$\sin\left\{k \,.\, (1 - \beta l) \,.\, \nu \,.\, \left[t - \frac{1}{c}\left(\frac{l - \beta}{1 - \beta l}x' + \frac{m}{k(1 - \beta l)}y' + \frac{n}{k(1 - \beta l)}z'\right)\right]\right\}$$

which is the same as the latter, provided that

$$\nu' = \nu \,.\, k(1 - \beta l),\ l' = (l - \beta)/(1 - \beta l),\ m' = m/k(1 - \beta l),\ n' = n/k(1 - \beta l)$$

[*Note.*—Two misprints in the original are here corrected.]

Let the movement of the ray be in a plane, and make an angle s with the axis of x in the system xyz and an angle s' in the system $x'y'z'$; then $l = \cos s$, $m = o$, $n = \sin s$, $l' = \cos s'$, $m' = 0$, $n' = \sin s'$. Let $s = 0$; then $\nu' = \nu \,.\, k(1 - \beta)$, whence $\Delta\nu/\nu = -\beta$, $\Delta\lambda/\lambda = \beta$, Döppler's law. The expression for l' gives $\cos s' = (\cos s - \beta)/(1 - \beta \cos s)$, whence approximately $\Delta s = \beta \,.\, \sin s$, the aberration law. The expression for n' gives $\sin s' = \sqrt{1 - \beta^2}\,.\, \sin s \,.\, (1 - \beta \cos s)$. Compare these with the true and eccentric planetary anomalies, $\cos v = (\cos E - e)/(1 - e \cos E)$ and $\sin v = \sqrt{1 - e^2} \sin E \,. /(1 - e \cos E)$. There are other analogies, but these cannot be pushed far. If in the foregoing we identify t' with t, the latter of Einstein's two light-vectors ceases to be a light-vector, and the light-vibrations are not at right angles to the ray; the true aberration law is not then arrived at. If, however, we can make x and t independent variables the difficulty disappears, and the motion is of the type $\partial^2 y/\partial t^2 = c^2 \,.\, \partial^2 y/\partial x^2$. A. D.

2203. *Determination of Curvature Invariant of de Sitter's Space-Time.* **L. Silberstein.** (Phil. Mag. 47. pp. 907–918, May, 1924.)—This empty space-time, originally proposed as a solution of Einstein's amplified field equations, and which is isotropic with respect to Riemannian curvature, is characterized by the line element

$$ds^2 = \cos^2 \sigma \,.\, c^2 dt^2 - dr^2 - R^2 \sin^2 \sigma (d\phi^2 + \sin^2 \phi\, d\theta^2),$$

where $\sigma = r/R$. The space-time of this quadratic form is the line element of an elliptic space, which the author here assumes to be of the polar kind so as to be covered by the interval $\sigma = 0$ to $\sigma = \pi/2$, and the constant R is the curvature radius. Then if G be the invariant of the curvature tensor G_{ik}, R will be given by $G = 12/R^2$. Thus R should have an intrinsic meaning, and if finite, it is of prime interest to determine it from a number of independent sets of observational data and see whether the R values so obtained are more or less mutually consistent. The author's objective is to show that this is probably the case. The formula of de Sitter for the Doppler effect is not applicable to actual stars, which cannot in the space-time here considered be at rest relatively to one another unless they coalesce or one is at the polar of the other. But Weyl [Abstract 1774 (1923)] has formulated a general principle for intrinsically computing a Doppler effect constructed for a star and an observer, each describing some geodesic $\delta \int ds = 0$ of de Sitter's space-time, or, in view of the practically evanescent transversal effect, a geodesic of its two-dimensional section $ds^2 = \cos^2 \sigma \,.\, c^2dt^2 - R^2d\sigma^2$ covering the case of all radial motions. Weyl, in applying this general principle, makes the gratuitous assumption of a universal scattering tendency of matter, which is not only improbable, but is contradicted by the case of the famous nebula in Andromeda and by the globular clusters generally. The author accordingly investigates the problem from the outset, but is unable to dispense with the assumption of the very questionable hypothesis of the permanence of atoms as "natural clocks," in Einstein's sense. The outcome of his investigation is that ten values of R are obtained from eight globular clusters and the Lesser and the Greater Magellanic Clouds, as follows: 6·7, 6·7, 2·2, 6·7, 4·7, 5·7, 9·1, 4·8, 8·2, 4·2, all multiplied by the common multiplier 10^{12} astronomical units. Plausible ground for assuming that the differences in these values may be attributed to observation errors in the data would give an average value $R = 5{\cdot}9 \times 10^{12}$ astronomical units. G. W. DE T.

2204. *The de Sitter Space-Time.* **P. du Val.** (Phil. Mag. 47. pp. 930–938, May, 1924.)—The author describes the hyperbolic fourfold by five coordinates, x, y_1, y_2, y_3, y_4. A point is fixed by their ratios, so if x be real all the coordinates will be real. The manifold of real points is divided into three groups—*actual*, for which $x^2 > \Sigma y^2$; *absolute*, for which $x^2 = \Sigma y^2$; *ideal*, for which $x^2 < \Sigma y^2$. It is shown that it is the elliptic case, not the spherical, of de Sitter's world which is the ideal field of the hyperbolic world. The curve in the latter along which $\int ds$ between any two points is stationary for all infinitesimal deformations which vanish at the two end points is the straight line. Thus in de Sitter's world the world-line of a particle is a straight line. Lines through any given point are either (1) time-like, *i.e.* containing real intervals (they are secants of the absolute); (2) minimal, *i.e.* containing zero intervals between non-coincident points (they are tangents of the abolute); (3) space-like, *i.e.* containing purely imaginary intervals between real points (they are non-secants of the absolute). G. W. DE T.

2205. *Dynamical and Kinematical Velocity in Einstein Relativity.* **P. A. M. Dirac.** (Phil. Mag. 47. pp. 1158–1159, June, 1924.)—The author refers to Eddington's proof [Mathematical Theory of Relativity, § 56] of the identity of the definitions of the dynamical and kinematical velocities for an isolated particle possessing three perpendicular planes of symmetry, and claims to have proved this identity without any postulates concerning the form of the particle by considering the conditions that hold at surfaces of discontinuity in a distribution of matter. [See also *loc. cit.*, § 66.]

G. W. DE T.

2206. *The Michelson-Morley Experiment.* **L. Strum.** (Zeits. f. Physik. 24. 1. pp. 20–23, 1924.)—The negative results hitherto obtained have been explained as being due to either an ether-drag by the earth or (Ritz, Tolman, Stewart) a velocity of light equal to the sum of c with the velocity of a moving source. But these do not explain the small positive results recently obtained by Miller. If, however, we assume the velocity of light from a moving source to be a function of the velocity of the moving source—say $c = c_0 + \alpha v$ where $a > 0, < 1$—we find as between the two positions a time-difference $(l/c_0)(v/c_0)^2(1 - 4\alpha + 3\alpha^2)$. When this $= 0$, $\alpha = 1$ or $\frac{1}{3}$. When (according to Miller) $(1 - 4\alpha + 3\alpha^2) = \frac{1}{16}$, we have α either greater than 1 or else equal to 0·286. Then a velocity $c = c_0 + 0{\cdot}286v$ would explain Miller's positive results; and a velocity $c_0 + v$ or a velocity $c_0 + \frac{1}{3}v$ would explain the absence of positive results. It is not impossible that the function above assumed may differ at different terrestrial heights. The previous experiments were carried out at moderate heights, Miller's at a height of 5900 feet.

A. D.

2207. *Aberration and Absolute Motion.* **R. Tomaschek.** (Ann. d. Physik. 74. 2. pp. 136–145, May, 1924.)—It is quite impossible either by Lenard's stationary ether, by dragged ether, or by relativity to reconcile (1) the wave-properties of light, (2) aberration, (3) Michelson and Morley's experiment, and (4) the phenomena of double stars. Lenard's hypothesis that each heavenly body has its own ether, dragged along with it and thinning away as the distance from it increases, and that space is filled with a proto-ether ("Urāther") at rest ("Äther und Urāther," 2nd edn., Hirzel, Leipzig, 1922), reconciles all the facts. The author examines Lenard's hypothesis, and concludes that the other explanations require additional hypotheses which are equivalent to Lenard's.

A. D.

METEOROLOGY AND GEO-PHYSICS.

2208. *Atmospheric Eddies.* **F. M. Exner.** (Meteorolog. Zeits. 41. pp. 175–179, June, 1924.)—A brief review is here given of recent work on eddy formation by Fujiwhara, Ryd and Ahlborn. The experiments of Fujiwhara on the formation of eddies in water (especially the growth of the larger at the expense of the smaller) are considered especially interesting, but the theory in its present state is not directly applicable to atmospheric processes.

W. A. R.

2209. *Whirlwinds.* **W. Hartmann.** (Meteorolog. Zeits. 41. pp. 101–109, April, 1924.)—Whirlwinds appear to originate in a vertical streaming column of air, which glides along with an acceleration. The acceleration originates in a billowy layer, formed at a stratification boundary. The motion in such cases is discontinuous. Mountains favour the formation of whirlwinds, and gliding surfaces in depression are also particularly favourable.

W. A. R.

2210. *Atmospheric Transparency and Weather States.* **W. Milch.** (Meteorolog. Zeits. 41. pp. 109–113, April, 1924.)—The observations indicating relations between atmospheric transparency to sunlight and weather states given in the paper were made at Taunus observatory. The measurement of atmospheric tubulence is useful for prediction. Four types were distinguished: (1) Approaching depression, giving steadily increasing turbulence; (2) undulating isobars with rapid, irregular changes in turbulence; (3) convection, showing symmetrical daily curves about the convection maximum; (4) inversion layer. W. A. R.

2211. *Atmospheric Electrodynamics.* **F. Schindelhauer.** (Phys. Zeits. 25. pp. 281–282, June 1, 1924.)—This paper forms a brief reply to F. Kaftan [Abstract 1704 (1924)], whose "electrodynamic" explanations of atmospheric processes are said to be ill-considered and unsupported by evidence. W. A. R.

2212. *Atmospheric Polarisation.* **J. J. Tichanovsky.** (Meteorolog. Zeits. 41. pp. 173–175, June, 1924.)—Two factors affect atmospheric polarisation: (1) Double refraction of the light by the atmosphere; (2) dispersion of the light by particles in the air. The first gives a dark blue colour, and the seconed gives a whiter and more diffused colour. The influence of these two factors explains the component colours of light polarised by the atmosphere. W. A. R.

2213. *The Measurement of Vertical Vision.* **A. Wigand** and **K. Genthe.** (Phys. Zeits. 25. pp. 263–270, June 1, 1924.)—Measurements of vertical vision have been conducted by means of a pilot balloon and theodolite [see Abstract 2043 (1924)], using the translucent glass method. Various balloons of rubber and glass are described, and the evaluation of the observations was accomplished by means of formulæ, tables and diagrams in the "Handbuch des Heereswetterdienstes." From the average data obtained between the ground and different balloon heights, the differences shown have enabled the vision values of separate atmospheric layers to be determined. Graphical representation of the results gives curves of state for vertical vision which enable strata distribution to be connected with that of wind, temperature, humidity and cloud. The typical structural elements of the vertical variation are claimed to be quantitatively comprehended by means of these new aerological methods. Very full details, with diagrams, are included in the paper. H. H. Ho.

2214. *Perturbations of Normal Atmospheric Electricity in Potsdam: Influence of Wind and Weather.* **H. Markgraf.** (Meteorolog. Zeits. 41. pp. 165–170, June, 1924.)—Analysis of observations in Potsdam from 1912 to 1921. E. F.

2215. *The Earthquake of March 15, 1923.* **G. Agamennone.** (Accad. Lincei, Atti, 33. i. pp. 136–140, Feb. 17, 1924.)—Further remarks [see Abstract 1713 (1924)] on the basis of a more extended series of world-wide data. A. D.

ASTRO-PHYSICS.

2216. *Determination of Time and Modification of Method of Corresponding Altitudes.* **G. Bigourdan.** (Comptes Rendus, 178. pp. 2141–2143, June 23, 1924.)—The method of transits by means of a fixed meridian instrument has hitherto been taken as the most accurate method of obtaining time, but different transit instruments may give results differing by a tenth of a second or more, even in the same locality. The author reviews six methods, and considers that the greatest precision is obtained by taking the corresponding altitudes of known stars, but suggests a modification, replacing the old spirit-level by a telescope, which is itself made the axis of rotation. Direct and reflex observations in a mercury bath should be made with this instrument, as is done in an ordinary meridian transit instrument, and thus the observing telescope can be made to preserve a constant position with regard to the vertical when passing from one star to another. Account must be taken of the variations in refraction between the observations. A. S. D. M.

2217. *Determination of Corrections to Equinox and Equator Point from Observations of Venus made at the Royal Observatory, Greenwich,* 1915–1923. **J. Jackson.** (Roy. Astron. Soc., M.N. 84. pp. 476–481, May, 1924.)—The underlying principle is that an observation of a neighbouring planet is equivalent to an observation of the earth from that planet. Thus from the 438 observations of Venus, during the last nine years, a good determination is made of the equinox and the earth's longitude. The plan followed is similar to that used by Hough at the Cape for observations made of the sun, Venus and Mercury in the years 1907–1916. The right ascensions depend on the adopted positions of the clock stars; the declinations were reduced with a latitude of 51° 28′ 38″·10. Pulkowa refractions, a term 0″·60 sine zenith distance for flexure, and the latitude variation given by the Cookson Floating Telescope. When the residuals from the N.A. positions were transformed into longitude and latitude they gave the following corrections: The adopted right ascensions are too large by + 0″·058; the declinations too small by + 0″·08; the longitude of the sun should be increased by + 0″·47 and the obliquity should be corrected by — 0″·29 ± 0″·07. The declinations treated directly give an increase of + 0″·18 (instead of the above + 0″·08), and the residuals in declination from the few observations of Mercury would indicate a correction at the equator of + 0″·06. A. S. D. M.

2218. *Cosmical Refraction.* **L. Courvoisier.** (Phys. Zeits. 25. pp. 187–188, April 15, 1924.)—The author replies to Kienle's criticism [Abstract 1107 (1924)] that in all his publications he has laid stress on the observed fact of the Courvoisier effect, and assumed a cosmical explanation only as a working hypothesis; and that it is not fair to select for criticism some of the series of observations adduced in evidence and to ignore a number of others. He shows that the Heidelberg observations of transits of Venus, and his reductions of these, are free from objection as material for this research; and he asks why, if the Courvoisier effect is due to atmospheric disturbances, as Kienle thinks, it should not affect eclipse plates as well as meridian-circle observations? In his opinion the problem of gravitational effect can only be solved by eclipse photographs which show absolute star-shifts (instead of merely differential), such as those which the German expedition to Mexico intended to take in 1923. M. A. E.

2219. *Radiation Equilibrium.* **R. Emden.** (Zeits. f. Physik, 23. 3–4. pp. 176–213, 1924.)—In a previous paper [see Abstract 1542 (1923)] the author has shown that Eddington's theory of the structure of stars can be derived independently of the idea of radiation equilibrium. The present paper discusses this viewpoint more closely, but not with the rigid degree of accuracy given in similar mathematical work of Jaffé [see Abstract 937 (1923)]. It is now shown that the dimensional order of the radii of giant stars may be calculated from spectral photographic observations. The differential equation of the radiation equilibrium and the consequent thermodynamic equations are derived, and from the data obtained an attempt is made to interpret the structure of gaseous spheres and stellar atmospheres. The relationships in a sphere of incompressible fluid in radiation equilibrium are found to be expressible in a closed form and serves for orientation purposes. The latter half of the paper discusses in detail certain investigations of Eddington and Kohlschütter. The principal deviation from the former is the deduction that if the molecular weights and the material constants are given, the masses of the possible giant stars in radiation equilibrium may be determined independent of their radii. All giant stars in radiation equilibrium and constructed of the same material must be of equal mass. This remarkable fact serves as a theoretical foundation for dealing with giant stars.

H. H. Ho.

2220. *Polarisation of Light from the Moon, Mars and Mercury.* **B. Lyot.** (Comptes Rendus, 178. pp. 1796–1798, May 26, 1924.)—The degree of polarisation of the light diffused from these bodies is plotted against the angle of diffusion. The curves are very similar in form. If light polarised in the plane of diffusion be denoted positive, and at right angles to this plane negative, the curve is of the following form: At zero angle the polarisation is zero, falling to a minimum value of 0·012 at about 10°. It becomes zero again at 24°, rising to a maximum of 0·04 — 0·09 at about 100°, and thence falling steeply. These results indicate that the three bodies are similarly constituted as regards atmosphere, and differ entirely from Venus, of which the polarisation behaves in another way. [Abstract 794 (1924).] A. Wh.

2221. *Diurnal Variation of the Temperature of the Surface of the Moon.* **R. Dietzius.** (Akad. Wiss. Wien, Ber. 132. 2A. No. 5–6. pp. 193–206, 1924.)—The question is treated mathematically, first by supposing conduction of heat in the moon's crust may be neglected, the temperature assumed by the moon's surface at any time being such as to give strict equilibrium between incoming and outgoing radiation; secondly, taking conduction into account. In the first case, supposing the coefficient of absorption of solar radiation and the coefficient of emission of low-temperature radiation by the moon both to have the value 0·87, the following are the temperatures (T) assumed by the moon's surface for different angles of incidence (i) of the solar beam.

i	0	10°	20°	30°	40°	50°	60°	70°	80°	85°	88°
T	126	125	119	111	100	85	63	32	−17	−56	−100° C.

Taking conduction into account, the relatively low value of conductivity applicable to a sandy surface is used (partly because the choice of a low value gives outer limits for the diurnal fluctuation of temperature), and the following table is arrived at :—

t	0	2	4	6	8	10	12	14	16	18	20	22
$\bar{T}$	384	372	339	232	229	222	211	207	199	195	286	361
W	−42	−20	9	44	29	25	20	20	20	10	−58	−56
A	240	215	147	51	30	27	22	20	17	16	75	187
B	281	244	141	0	0	0	0	0	0	0	141	244
ξ	−1·60	−0·74	0·32	1·68	1·10	0·96	0·76	0·75	0·75	0·37	−2·20	−2·14

Here t is the time in moon-hours starting from mid-day as 0, $\overline{T}$ is the temperature of the moon's surface in ° abs., W is the vertical transport of heat at the surface by conduction (unit, 10^{-4} cal. cm.$^{-2}$ sec.$^{-1}$), A is the outward flux by radiation, and B the inward flux by radiation in the same units as W, and g is the vertical temperature gradient in the crust at the surface in ° C./cm. The figures relate to a place on the equator. The lowest temperature, just before sunrise, is 194° a.; the mid-day temperature is 384° a.; and the maximum is 385° a., the last occurring about one-third of a moon-hour (*i.e.* about ten earth-hours) after moon mid-day. The mid-day temperature falls short of the radiation equilibrium temperature above by only 15° C.

The paper also contains a discussion of the earlier observations and conclusions of Langley, Very and Coblentz, and also deals with the relative intensities of the long-wave radiation emitted by the moon and the reflected solar radiation. M. A. G.

2222. *Rotation Period of Sun, Derived from Greenwich Measures of Solar Faculæ.* *Greenwich Observatory.* (Roy. Astron. Soc., M.N. 84. pp. 431–442, April, 1924.)—Faculæ are in themselves more difficult to measure than sunspots, but they are longer lived, and when they disappear they do so as a whole, and not as in sunspots, where the following spots die out before the leader. Therefore small, persistent faculous entities, with intervals of 27 or 54 days, offer good material for determining the sun's rotation. The material is drawn from the years of smaller solar activity between 1888 and 1920. The conditions for selection of faculæ and the method of reduction are described, and a list is given of the actual faculous groups used. Two empirical formulæ are derived for the variation of the rotation with solar latitude: (1) $\xi = 14°\cdot54 - 2°\cdot81 \sin^2 \phi$, and (2) $\xi = 14°\cdot49 - 1°\cdot78 \sin^2 \phi - 3°\cdot16 \sin^4 \phi$, and a comparison is given with formulæ derived by other observers of faculæ or from other solar phenomena, the agreement between formula (1) and that by Philip Fox, for calcium flocculi, being very close. A. S. D. M.

2223. *The Solar Constant.* **F. Linke.** (Meteorolog. Zeits. 41. pp. 74–78, March, 1924.)—The author challenges the conclusion that the solar constant presents variations. He discusses the sources of error in instrumental observation and in extrapolation, and points out the importance of the afternoon dustiness of the air at high altitudes. A. D.

2224. *Influence of Comparison Stars on Photographic Proper Motions.* **J. Jackson.** (Roy. Astron. Soc., M.N. 84. pp. 401–409, April, 1924.)—The author discusses the influence of the random proper motions of the comparison stars on plate constants with special reference to van Maanen's proper and internal motions of spiral nebulæ. He considers certain ideal cases, and shows that van Maanen's introduction of squared terms influences seriously the probable error of the plate constant a. He finds that the value of ϵ, the probable proper motion of a comparison star, combined with the probable error of measurement, may be greater than 1″ per century in each coordinate, and that if the proper motions obtained by van Maanen for the spiral nebulæ are treated as entirely due to accidental errors, they indicate a probable error of about 0″·6 in each coordinate, and that if ϵ be taken at 1″·4 per century, the proper motions of the nebulæ in space can be explained. But the influence of the comparison stars on the internal motions of the spiral is much less marked; the average probable error found by van Maanen cannot exceed 0·3ε, and the actual motions are of the order 3″·0 for rotational and 1″·0 for radial motion. As far as the comparison stars are concerned, the position will not be improved by increasing the interval between the plates. [See also Abstract 1732 (1924).] A. S. D. M.

2225. *Recent Observations of Some Bright-Hydrogen-Line Stars.* **W. J. S. Lockyer.** (Roy. Astron. Soc., M.N. 84. pp. 409–425, April, 1924.)—A continuation of the study of the variable line H_β [see Abstract 1798 (1923)], as it appears in 21 stars (of which the one most often observed is ζ Tauri) photographed recently (1923–24), and compared with earlier observations by P. W. Merrill (in 1911–12) and R. H. Curtiss (1916 and 1920). The most interesting cases where notable changes were found in the appearance of the hydrogen lines are: φ and ψ Persei, η, ζ, 17 and 27 Tauri, υ Cygni, 25 Orionis, and H.D.C. 20336. All the photographs were taken with the 9-in. Prismatic Camera of the Norman Lockyer Observatory, with a prism of 45° angle and a dispersion of 46·0 mm., between H_β and H_ϵ. The author summarises the recorded appearances of the hydrogen lines, and illustrates by a plate eight of these bright hydrogen line stars. A. S. D. M.

2226. *Pressures at the Sun's Surface.* **H. N. Russell** and **J. Q. Stewart.** (Astrophys. J. 59. pp. 197–209, May, 1924. Paper read before the Nat. Acad. Sci., April, 1923.)—*Estimation of Solar Pressures.*—The available methods of estimating the gas pressures which prevail at the sun's surface are based upon: (1) Pressure shifts of Fraunhofer lines. (2) Sharpness of lines sensitive to pressure. (3) General opacity of the outer regions of the sun. (4) The absence of scattered sunlight in the flash spectrum. (5) Widths of Fraunhofer lines. (6) The gravitational equilibrium of the outer regions of the sun. (7) Radiation pressure. (8) Ionisation and chemical equilibria in the solar atmosphere. Previous work is reviewed, and new material presented under (2), (4), (5), and (8). All lines of evidence agree with the conclusion that the total pressure of the *photospheric gases* is less than 0·01 atmosphere, and that the average pressure in the *reversing layer* is not greater than 0·0001 atmosphere.

Constitution of the Solar Atmosphere.—It is probable that the chromosphere is supported by radiation pressure, and that the gas pressure at its base is of the order 10^{-7} atm. In the next 200 km. (the *reversing layer*) the pressure increases to 10^{-2} atm. Below this level general absorption produces rapidly increasing opacity, resulting in the photosphere. The whole amount of matter above the photosphere is of the order 10^{-4} gm./cm.^{2}, equivalent to a layer of ordinary air 10 feet thick.

Similar considerations apply to the great majority of *stellar atmospheres.* Thus it is probable that the lines in most stellar spectra are produced substantially under vacuum conditions.

Widening of Hydrogen Lines by Stark Effect.—A more detailed calculation shows that the extreme width of H_β in a stellar spectrum, due to Stark effect in the ionized gas, may be more than one hundred times the mean width recently calculated by Hulburt under certain simplifying assumptions. This recalculation leads to much lower pressures than Hulburt computed.

Dissociation of TiO_2 Vapour in the Solar Atmosphere.—Atkinson has calculated this, assuming the oxygen to be in the molecular state. It is almost certainly in the atomic. This modifies his equations, and leads to higher computed pressures.

In each of the foregoing cases the recalculation leads to values of the pressure in agreement with the results of other methods. AUTHORS.

2227. *Study of Distribution of Energy in Some Stellar Spectra.* **J. Baillaud.** (Comptes Rendus, 178. pp. 1604–1606, May 12, 1924.)—The spectral curves of energy for types F5, A and B, are sharply differentiated, and for F5 stars that for the dwarf Procyon alone resembles that of a black body. The curves for A and B do not resemble that of a black body for shorter wave-lengths than λ500 *mμ*. Certain B-stars (γ Cassiopeiæ, ε Orion) show a sharp diminution of energy in the extreme ultraviolet. A-stars show a maximum energy near λ400 *mμ*. It is inferred that the cause of the continuous spectrum is not the same for white and yellow stars. A- and B-stars are masses of gas with a central nucleus under great pressure, their atmospheres being rare and greatly extended. In A-stars the radiation from the nucleus is the more important; in the B-stars the emissions from its atmosphere predominate over all the nuclear radiations. A. S. D. M.

2228. *Effective Wave-length and Spectral Classification of Faint Stars. Standards of Reference.* **C. R. Davidson** and **E. Martin.** (Roy. Astron. Soc., M.N. 84. pp. 425–431, April, 1924.)—Bergstrand and Rosenberg in "Astron. Nachr." 5159 suggest a list of 25 stars near the North Pole as suitable for standards for a colour Durchmusterung for faint stars, being of spectral types, B to M, and of the 5th or 6th magnitude. At Greenwich these have been photographed between 1923, July 26, and 1924, March 11, with the 30-in. reflector stopped down to 20 inches, with a wire grating of equal bar and space and of approximately 3·0 mm. pitch, several stars being on each plate. Two sets of exposure were given in the ratio 1 : 3, so that the intensities differed by one magnitude, and the length of exposure is such that one set is fainter and the other brighter than the adopted standard intensity, *i.e.* ten minutes exposure on a 10th magnitude star. Tables are given of the name, place, magnitude, colour index and spectral type of the standard stars; of their measured effective wave-length; of their adopted effective wave-length; and of the equivalent spectral type of the effective wave-length. These provide provisional standards, and for definitive standards the authors suggest the adoption of a reflecting telescope as the standard type; the definition of the density of the standard image; the correction to the zenith of the effective wave-length; and the checking of the quality of the sky whenever observations are made by exposing on a field near the North Pole. [See Abstract 798 (1922).] A. S. D. M.

2229. *Spectra and Temperatures of the B-Stars.* **Cecilia H. Payne.** (Nature, 113. pp. 783–784, May 31, 1924.)—Fowler and Milne have shown [Abstract 1810 (1923)] that the effective temperature at a given point in the stellar sequence may be deduced from the knowledge that a line of known series relations reaches there its maximum intensity. From recent measurements of a number of spectra at Harvard College Observatory it is found that helium lines of the 1P — *m*D series reach their maximum intensity at stellar type B3, and this indicates a temperature of about 16,000° for stars of this type. A diagram is given which shows the rise and subsequent fall of intensity in these lines in going from type 0*e*5 to A*o*, and also the corresponding temperature for each type deduced from silicon, helium, and carbon lines.

Edwards has recently determined the absolute magnitudes and parallaxes of B-stars [Abstract 1736 (1924)] by measuring the differences of intensity between these helium lines and the hydrogen lines H_γ and H_δ, and his results show a general decrease of absolute magnitude with advancing type. This was, however, to be expected, for the spectral sub-types of B-stars were determined by using helium lines with identical intensity-changes as a criterion, and the hydrogen lines also vary with type; his measures therefore simply confirm the well-known statistical correlation of type and absolute magnitude in B-stars. Moreover, the parallaxes he uses in forming his reduction curves are not always the best obtainable. M. A. E.

2230. *Vestiges of Spiral Structure in Star Clusters.* **P. Bruggencate.** (Zeits. f. Physik. 24. 1. pp. 48–51, 1924.)—It was first noted by Shapley that the giant stars in globular clusters are bright in proportion to the redness of their colour, which indicates that all stars of a globular cluster had the same origin, but that the most massive, taking the longest time to develop, are in the earliest stage. The phenomenon is observed also in some open clusters, such as M37 and M11, although it is less marked here, doubtless because many stars of the Milky Way, external to these clusters, are seen in projection upon them. Freundlich and Heiskanen have found that the B-stars in the globular cluster M13 show evidence, by their present grouping, of having been originally grouped in a spiral. Following up these indications of the past history of clusters, the author shows that when the brighter and the fainter stars near the centres of the globular clusters M3 and M15 are plotted separately, the fainter stars are seen to be arranged in an ellipse, while the brighter stars show an approximately spiral structure. In M3 two spiral arms start from the opposite extremities of the major axis of the elliptical nucleus, as required by Jeans' theory. The distribution of A and B stars has also been investigated in the open cluster M37, and it appears that here also vestiges of a spiral structure are to be found. The paper is illustrated by five diagrams. M. A. E.

2231. *Distribution of Stars.* **H. Shapley.** (Scientific Monthly, 18. pp. 449–455, May, 1924. Harvard reprint, 8.)—No analysis of stellar distribution is of great value which ignores the disc form of the Milky Way, the eccentric position of the sun, and the non-homogeneous character of our neighbourhood; we must take into account both galactic latitude and longitude. The sun is near the great Cygnus star cloud, and the preferential drift of rapidly moving stars is an indication and measure of its velocity with respect to the Galaxy and the Local System. There are large obscuring nebulosities distant a few hundred parsecs in Taurus, Ophiuchus and from Sagittarius into Aquila. [See Abstract 1728 (1924).] In the Milky Way, classes A and K, being giants, are the more numerous on a basis of a unit of surface; the dwarf stars are more numerous on a basis of a unit of volume. Probably K and A are long periods in the evolutionary sequence. Stars in the solar phase of development are 1800 times as numerous as the highly massive and luminous B-stars, and

350 times as numerous as the giant M-stars. This proportion of B to M suggests that few stars have sufficient mass to attain the highest surface temperatures. There are in a million cubic parsecs, in low galactic latitudes, 22 giant M-stars, 4·4 B-stars, 680 dwarf F- and 7600 dwarf G-stars, but the space explored for B-stars is about $1 \cdot 5 \times 10^8$ cubic parsecs. Most stars in low galactic latitudes are dwarfs, and this suggests that the evolution through known spectral types is a matter of the past, or that the development in the dwarf stage is slower than in the giant, or that large masses are infrequent and small masses evolve rapidly in early life. Some of the fainter stars extend to beyond 3000 parsecs, but more than 95 % of all the stars in the Henry Draper Catalogue are within 1000 parsecs of the sun, and only about one-millionth of known space is covered by the Catalogue. B- and early A-type stars are more concentrated to the galactic plane than later classes; B-stars fainter than the 8th magnitude are almost all members of the general galactic system; the brighter B-stars are in the Local System in Carina, and show that the central plane of this is inclined 10°–15° to the galactic plane. M-variables are four times as numerous in the Sagittarius direction towards the centre of the galaxy than in the opposite direction. A. S. D. M.

2232. *The Spectroscopic Parallaxes of A-Type Stars.* **B. Lindblad.** (Astrophys. J. 59. pp. 305–309, June, 1924.)—*Comparison of the Harvard and Mt. Wilson Classifications of A-type Stars.*—The difference between the reduction curves for deriving absolute magnitude used by Adams and Joy for A-type stars with "sharp" and "nebulous" spectral lines respectively seems to be due entirely to a systematic difference in the Mt. Wilson type for these two kinds of spectra. Within the Harvard interval A0–3 the Mt. Wilson spectral type seems to be correlated with the exposure-ratio for the regions λλ3895–3907 and λλ3907–3925, measured in short objective-prism spectra. There are strong indications that the subdivisions by Adams and Joy of the A-type in their relation to the original Harvard sequence, at least for the Harvard interval A0–3, have the character of a *luminosity classification*—*i.e.* a classification dependent on the atmospheric density-gradient of a star in addition to the surface temperature. This circumstance helps to explain the probably small range of luminosity within each Mt. Wilson subdivision. Improvements in the method of classifying short and narrow objective-prism spectra of early type are suggested. AUTHOR.

2233. *The Distribution of the Poles of 362 Spiral Nebulæ.* **C. C. L. Gregory.** (Roy. Astron. Soc., M.N. 84. pp. 456–467, April, 1924.) W. R. C.

2234. *The Parallax and the Orbital Motion of ξ Ursæ Majoris.* **C. L. Stearns.** (Astron. J. 35. pp. 157–159, May 12, 1924.)

LIGHT.

2235. *Optical Effects of Motion.* **P. Zeeman.** (Nature, 113. pp. 838–839, June 7, 1924.)—Three optical effects of motion are at present known—astronomical aberration, the Doppler effect, and the Fizeau effect. The Fizeau effect has been investigated with moving transparent solid substances. The formula is different from Fizeau's, but the calculated and observed values of the interference fringes are in excellent agreement. The observed shift of the interference bands is in perfect agreement with relativity mechanics. Tests are in progress as to the relativity relations of Doppler's effect. A. D.

2236. *Optical Resonance Reflection and Diffusion.* **E. Fermi.** (Accad. Lincei, Atti, 33. i. pp. 90–93, Feb. 3, 1924.)—Mathematical treatment of R. W. Wood's resonance reflection and diffusion [see Abstract 1182 (1912)]. Best experimental conditions deduced from the general formulæ obtained. A. D.

2237. *Quantum Reflection and Refraction of Light.* **L. Brillouin.** (Comptes Rendus, 178. pp. 1696–1698, May 19, 1924.)—Pursuant to the theories developed by several authors [see Abstracts 20 (1923) and 576 (1924)] of the explanation of a number of classical optical phenomena by the utilisation of the relationships of quanta and relativistic mechanics, a line of mathematical reasoning is followed which fits in with the classical laws of reflection and refraction. A. B. C. L.

2238. *The Isotropic Increase of the Refractive Index of Liquids in an Electric Field.* **Pauthenier.** (Comptes Rendus, 178. pp. 1899–1902, June 2, 1924.)—Experiments were made to determine the increase in refractive index of benzene and carbon tetrachloride when submitted to a uniform electrostatic field. The results, obtained by an interference method, show the existence of electrostriction equivalent to a condensation of the liquid in a uniform electric field; the effect is of the order to be expected from calculations by Helmholtz and Pockels. W. V. M.

2239. *Mass Refraction of Ions and Molecules in the Light of the Atom Structure.* **K. Fajans** and **G. Joos.** (Zeits. f. Physik, 23. 1–2. pp. 1–46, 1924.)—A series of chemical and physical characteristics of inorganic compounds can be coordinated when considered from the single point of view that when more complicated systems are formed from simpler elements the electron enclosures of the latter experience a change or deformation. Especially simple is the case of free gaseous ions coming together to form molecules or crystal lattices. There may be then a deformation of the anion by the field of the positive charge of the kation, and this deformation, shown by easily established optical changes, permits of the explanation of the behaviour of the salts formed in relation to their lattice distances, lattice energy, liquidity, solubility and capability of dissociation. At the basis of the various speculations lies the hypothesis, derived from the classical theory, and developed already by Debye in his explanation of the van der Waal's forces, that the mass refraction (for infinitely long waves) affords a measure of the deformability of the electron enclosures. Starting from the proposition that in ions with similar structure of the electron enclosures (*e.g.* ions of the same perfect gas type) and of various charge the fixity of combination of the electrons must decrease with falling nucleus charge, and so the deformability must increase, there could be obtained from the mass refraction of the perfect gases and of the alkali-halogens in solution individual values of the refraction for alkali and halogen ions, and hence also for many other ions in solution. The values so obtained agree to a first approximation with those found by J. A. Wasastjerna on the basis of the hypothesis that for the hydrogen ion of the watery solution as an electron-free structure the refraction has a null value. Yet this assumption proves unfitted to serve as the starting-point of an exact valuation of the individual refractions of the ions. With complex systems (solutions, solid salts, complex ions, molecules) each deviation from the additive behaviour of the Lorenz-Lorentz refraction would be explained in the sense of a deformation of the electron enclosures of the components, and with analogous structures the change of the refraction would be looked upon as a measure of the deformation. It thus occurs that kations (H-nucleus, kations of perfect gas structure, and such as have eighteen external electrons) act on the water in solution, as also on the anions in solid salts, in the sense of a lessening of the refraction. The deformation is so much the greater the stronger the electrostatic field of the deforming kation; that is, the smaller and the more highly charged it is and the greater is the deformability (refraction) of the anion. The fact that on the solution of salts there often occurs an increase of the refraction is explained in this way, that the refraction of the water through kations is less decreased than that of the many anions in solid salts. On the basis of optical observations the hypothesis is supported that the hydrogen nucleus in watery solution gathers itself up into a H_2O-molecule with weakening of its refraction and formation of the complex kation H_3O^+. The observation brought forward by Prytz and Bleeckrode that on the passage from the gaseous to the fluid state the Lorenz-Lorentz refraction in many cases is markedly lessened is explained in the sense of Debye's theory of the van der Waal's forces as an indication of the opposite deformation of the electron enclosures of the neutral molecules. J. J. S.

2240. *Colours of Crystals of Chlorate of Potash.* **L. A. Ramdas.** (Indian Assoc. for Cultivation of Science, Proc. 8. 4. pp. 231–242, 1923.) —The presence of dust or other suspended or dissolved impurity is necessary in order that iridescent crystals may be obtained by the crystallisation of solutions of potassium chlorate. The following values of the refractive index of the crystals for different wave-lengths were determined: λ6500 A., 1·529; 5896, 1·531; 5000, 1·539; 4500, 1·544; 4000, 1·549. Spectro-photometric measurements of the light reflected from the crystals confirmed Rayleigh's theory of the reflection of light by twinned crystal planes. J. S. G. T.

2241. *The Colour of the Sea. Part II.* **W. Shoulejkin.** (Phys. Rev. 23. pp. 744–751, June, 1924.)—*Spectro-photometric observations of the inner diffused up from Polar seas* were made, using a special instrument which enabled a direct comparison at various wave-lengths of the light diffused vertically up from the sea with the direct light from the sun and sky. The curves obtained agree well with the formula derived in the previous paper. *Measurements of the coefficient of diffusion made with the Secchi disk,* by means of the author's theory, agree with values of the coefficient α determined from laboratory data for the Indian Ocean (by Ramanathan) and for the pure water of the Sargass Sea (compared with α for distilled water according to data given by Martin). Recent papers by Raman and by Ramanathan, who consider exclusively molecular scattering, are discussed. When the intensity of the diffused inner light is small, the colour of the sea depends almost entirely upon light reflected from the sky.

The coefficient of reflection of a leaf of *laminaria* from the bottom of Warneck Bay varies with wave-length very closely in proportion to the reciprocal of the intensity of the illumination at that depth computed from spectrophotometric data. In the case of *Mediterranean coral* from a depth of about 70 metres, good agreement was also found up to 0·59 μ, above which the illumination is extremely weak. [See Abstract 242 (1924).] AUTHOR.

2242. *Colours of Colloids in Relation to the Size of the Dispersed Particles.* **B. Ray.** (Indian Assoc. for Cultivation of Science, Proc. 8. 3. pp. 221–230, 1923.)—The gradual changes of colour of the light transmitted through colloidal solutions with increase in the size of the particles, the colours of "metal glasses," and the axial colours seen through droplets of water, alcohol, etc., are theoretically considered. It is argued that the intensity of the transmitted light is determined by (1) the decrease in area, and consequently also of the resultant effect of the undisturbed portion of the wave-front; and (2) the interference with this light of the light scattered in the direction of the primary wave by the particles lying in the wave-front; and from these considerations a formula is obtained, involving the amplitude and phase of the secondary waves, which is in agreement with the colour development and the oscillatory character of the intensity observed in experiment. A. B. C. L.

2243. *Scattering of Light by Smoky Quartz.* **N. K. Sur.** (Indian Assoc. for Cultivation of Science, Proc. 8. 4. pp. 271–275, 1923.)—From an experimental study of the relationship between the ratio of the intensities of the incident and transmitted light and the wave-length of the transmitted light it is concluded that the opacity of smoky quartz is not wholly due to scattering, but that there is some real absorption also. This is confirmed by a comparison of the ratios of the intensities of the scattered radiation from smoky quartz and a sulphur suspension and the respective absorption coefficients. A. B. C. L.

2244. *Optical Properties of Turbid Media.* **Margarete Weiler.** (Ann. d. Physik, 74. 4. pp. 347–361, June, 1924.)—Colloidal solutions of mastic in distilled water are shown to be turbid media in the sense of the Rayleigh theory, and the laws established for the extinction of light in atmospheric air are found to be valid for such emulsions also. Dember and Uibe's law, $s \propto \sqrt{H}$, giving the relation between the brightness of the sky, H, and the distance, s, at which a light source just ceases to be perceptible, is true for other turbid media in so far as the Rayleigh conditions are satisfied, and a similar relation holds between brightness and the distance at which an object of given tone just becomes indistinguishable from its surroundings. If a real absorption comes in, or if the particles are too large, circumstances excluded by the Rayleigh theory, then these laws are no longer true. G. A. S.

2245. *A Reference System for Primary Aberrations.* **T. Smith.** (Optical Soc., Trans. 25. 3. pp. 130–134, 1923–1924.)—All the primary aberrations are fully known when the state of correction for all points on the axis is given. The condition in which the whole length of the axis is free from aberrations is suggested as a standard of reference for general investigations, the departures from which in the cases normally required are functions of the positions of the object, the stop, and the focal length only. The inevitable departures from the standard in the case of a thin lens and of a system of two separated thin lenses for first order aberrations are considered and shown to affect the curvature terms. In general the distinctions between the new reference system and that in which an inverted image equal to the object and a stop in a unit surface are adopted are confined to the symmetrical aberration terms. AUTHOR.

2246. *The Determination of Aberrations, as expressed in Geometrical Optics, from the Indications of the Hilger Interferometer.* **J. W. Perry.** (Optical Soc., Trans. 25. 3. pp. 97–104; Disc., 105–106, 1923–1924.)—The paper describes and illustrates methods of deriving from the indications of the Hilger lens-testing interferometer quantitative expressions for the aberrational defects of a lens system, in terms of the departure from ideally perfect focal ray-union, as measured longitudinally at the focal plane and as obtained in the course of computation of an objective. AUTHOR.

2247. *A New Form of Corneal Microscope with Combined Slit Lamp Illuminating Device.* **E. F. Fincham.** (Optical Soc., Trans. 25. 3. pp. 113–118; Disc., 118–122, 1923–1924.)—For the clinical examination of the cornea and anterior portions of the interior of the living eye—a procedure often necessary—a specially mounted microscope, monocular or binocular, is used in conjunction with a so-called slit lamp. In the apparatus as used at present two instruments are separately mounted and must be adjusted independently. This paper, which is the outcome of some experiments made in the Department of Applied Optics of the Northampton Polytechnic Institute, London, upon the microscopic examination of the living eye, describes a combined instrument in which the adjustment is common to both the microscope and the lamp, thus greatly facilitating the observation. AUTHOR.

2248. *The Choice of Wave-lengths for Achromatism in Telescopes.* **J. W. Gifford.** (Optical Soc., Trans. 25. 3. pp. 123–127; Disc., 127–129, 1923–1924.)—In correcting a combination of two glasses for chromatism, focal lengths for two colours of the spectrum are made equal. The outstanding error for other such colours is called the secondary spectrum. This paper has been written for the purpose of determining the effect on the secondary spectrum of varying the two colours chosen. These effects, calculated by trigonometrical trace, are illustrated by graphs and tables. AUTHOR.

2249. *The Waetzmann Interference Method of Investigation of Optical Systems.* **E. Bratke.** (Zeits. f. Physik, 23. 3–4. pp. 239–257, 1924.)—This is the second part of a paper on Waetzmann's method [Abstract 1144 (1924)], and in it the question is investigated whether the method can be applied to quantitative measurements. First the theory of the interference phenomenon lying at the base of the method is given. With this theory are carried out calculations of interference curves, and the latter compared with experiment whereby full agreement is attained. Next it is shown that under certain definite conditions which must be fulfilled it is possible to determine the spherical and chromatic aberration of a system by working backwards from the observed interference curves. J. J. S.

2250. *Use of the Lummer Plate.* **G. Hansen.** (Zeits. wiss. Phot. 23. pp. 17–29, June, 1924.)—Several points are indicated to which attention must be paid if the most is to be made of the serviceability of the Lummer plate. The temperature must be carefully kept constant, and the direction of polarisation of the light which is admitted to the plate must be parallel to the plane of incidence. Two methods of working out the results are compared, and a numerical method of interpolation is described, the degree of accuracy attainable by it being examined.

G. A. S.

2251. *Colours of Mixed Plates.* **K. S. Rao.** (Indian Assoc. for Cultivation of Science, Proc. 8. 4. pp. 243–253, 1923.)—The intensity distribution of the halo exhibited by the mixed plate is studied and explained, and the position of the achromatic ring determined. The phenomenon observed in the case of dry films is shown by quantitative measurements to belong to the class of Newton's diffusion rings.

G. A. S.

2252. *Calculations concerning Prism Objectives, with Examples of their Application.* **H. Cranz.** (Zeits. Instrumentenk. 44. pp. 237–260, June, 1924.)—The present investigation has been demanded by the increasing employment of total reflecting prisms in telescopes for the purpose of reducing their length through the zig-zag path of light in the prism and for the complete and efficient reversal of the image. If such a prism be inserted between objective and ocular, its terminal surfaces must be perpendicular to the optic axis, otherwise astigmatic disturbance will arise. A disadvantage of the installation, particularly apparent for strong magnifications, is that the prism acts as a thick plane parallel plate, and the focus of the object is displaced thereby without the focal distance of the objective being altered, and the displacement varies for each colour. Harting's work on the correction of this fault is mentioned. A further drawback is the unavoidable loss of light at each refracting surface. Two fitting spherical surfaces act as one when a suitable refracting cement is used, and this method is now adopted for combining prism and objective, the plane end surfaces being replaced by suitable spherical ones. The two objective lenses can thus be separated by the prism, and so a double-cemented combination is obtained consisting of two thin lenses and a very thick central one. Investigation is then made of the curvatures which the four spherical surfaces must possess in order that the focal distance F and the distance of the focus from the rear prism vertical B shall remain constant for different colours. § 1 develops formulæ for the passage of light through four spherical surfaces of finite distance apart and two varieties of glass; § 2 deals with the ray path in the prism objective; § 3 with the limits of the field of vision in the prism objective; § 4 with data for two serviceable kinds of glass; § 5 with special cases;

§ 6 with examples of prism objectives without rear lenses ; § 7 with the case $F > B + l$, where l is the path ; § 8 examines case of $F < B$; and § 9 special case of $F = B$; § 10 applies an approximation method for consideration of the thick lens ; and § 11 assembles the formulæ for trigonometrical calculation. The paper is mathematical throughout. H. H. Ho.

2253. *Grating Fringes.* **V. Ronchi.** (Accad. Lincei, Atti, 33. i. pp. 23–28, Jan. 13, 1924.)—Discussion of combination-fringes from ex-centred gratings, which in the study of optical surfaces and systems are found to be much more sensitive than parallel gratings. A. D.

2254. *Diffraction Image of Two Close Luminous Lines of Finite Width.* **B. E. Mourashkinsky.** (Phil. Mag. 47. pp. 1105–1120, June, 1924.)—The case of one line of finite width is dealt with first, and formulæ are derived from which the intensity of the light at points in the geometric shadow can be calculated. These calculations are carried out for various slit widths, and the results given in tables. For narrow lines the position of the maxima and minima of illumination are shown. Above a certain width there are no sensible maxima and minima. The case is then extended to two lines, tables again being given, one table showing the absolute limits of resolution of the lines. Broader lines are resolved at less distances between the edges. Finally, the application of the results to the problem of the resolution of two close luminous lines of finite width by an object glass is discussed. A. A. D.

2255. *On Stationary Light Waves at a Great Distance from Reflecting Surfaces.* **K. Leistner.** (Ann. d. Physik, 74. 4. pp. 325–346, June, 1924.)—The paper commences with an historical *résumé* of the subject, the work of Wiener, Drude, Nernst, Izarn, Cotton and Selényi [see Abstract 1674 (1911)] being briefly mentioned. It is now shown possible to produce and establish the formation of stationary light waves when the necessary light rays of opposed directions of propagation have travelled a path of about 24 cm. long. Experimental details are very fully given. The opposed wave trains were so obtained that a light pencil was divided into two parts by a semi-permeable silver layer. By this means the reflecting mirror of previous experiments was avoided, and the stationary light waves more conveniently observed. Experimental difficulties and the means for their solution are adequately discussed. It was found that the interference refractor arrangement could be employed, this possessing a high sensitivity for measurements of length. The proof of the existence of stationary light waves was afforded by various means, *e.g.* scattering by ultramicroscopic particles and chemical photographic effect on a silver chloride collodion film. The same light vector was found for the maximum effects in both phenomena. The effects of stationary waves simultaneous with ordinary interference phenomena were rendered visible together. Analogous to the known experiments of Wiener on the vibrational direction of polarised light, the light movement was investigated by means of thin scattering layers, which produce two perpendicular polarised light pencils. Full agreement was found with the observations of Wiener and Selényi. H. H. Ho.

2256. *The Colours Produced by Rotation of the Plane of Polarisation in a Quartz Plate Ground Perpendicular to the Axis.* **C. Pulfrich.** (Zeits, Instrumentenk, 44. pp. 261–270, June, 1924.)—The author has found in a number of manuals dealing with crystallography and physics that an explanation is given for colours which are not present when a quartz plate, ground perpendicular to the axis, is placed between two Nicols, while the colours which actually arise are practically unmentioned. The present paper seeks to remedy this defect, and supplies such a detailed examination of the problem, illustrated with eleven diagrams. The paper should be consulted in its entirety. H. H. Ho.

2257. *Depolarisation of Light by Suspensions.* **O. Groll.** (Phys. Zeits. 25. pp. 233–238, May 15, 1924.)—Procopiu has shown that if a suspension be interposed between crossed Nicols a brightening of the field of view is noticed which is incapable of complete extinction by the rotation of the analyser. This indicates partial depolarisation of the light, and a method is described by which the degree of depolarisation can be measured. The results of experiments with crystalline and non-crystalline suspensions show that double refraction must be an important factor in the explanation of depolarisation. If $\sin^2 \alpha$ is the fractional intensity of ordinary light in the transmitted beam, α is found to be proportional to the concentration for a given suspension and proportional to the thickness of the layer for a given concentration. With increasing size of particles α diminishes. When the liquid and the particles have relative refractive indices which encourage total reflection at the individual particles α is reduced. The wave-length of the incident light also influences the phenomenon.

The suspensions examined by Procopiu are investigated, and figures are also given for a number of new substances, including gelatine and celluloid under different conditions, and vanadium pentoxide solution of various concentrations. In the latter case the degree of depolarisation is found to increase with the age of the solution, most markedly so when the concentration is small. G. A. S.

2258. *Depolarisation of Light by Suspensions.* **W. Koenig.** (Phys. Zeits. 25. pp. 238–239, May 15, 1924.) [Notes on the work of O. Groll, see preceding Abstract].—The law, $\alpha \propto$ thickness, found by Groll, is not what simple theory would lead one to expect. Experiments undertaken by Seip specially to test this point show that the theory is nearly followed for weak concentrations, but as the concentration increases the law more nearly approaches that found by Groll. This can be explained if account be taken in the theory of the increased depolarisation that takes place with increasing concentration. These considerations seem to contradict the view that α varies as the number of particles met, and one would not expect the relation $\alpha \propto$ concentration to be true either. Further experiments by Seip, however, confirm this law over a wide range of concentrations. G. A. S.

2259. *Origin of the Anomalous Rotatory Dispersion of Tartaric Acid.* **T. M. Lowry** and **P. C. Austin.** (Comptes Rendus, 178. pp. 1902–1904, June 2, 1924.)—The anomalous rotatory dispersion of tartaric acid was attributed by Arndtsen in 1858 to the superposition of the opposite normal rotation of two forms of the acid, which have recently been described by Longchambon [Abstract 1441 (1924)] as α and β tartaric acid. Longchambon's view that the lævorotatory α form of the acid is identical with that which exists in the crystals (which give a normal lævorotation) is accepted; it is, however, urged that dilution with a large excess of water does not give the pure β-acid, but a dextrorotatory equilibrium-mixture of the α and β acids. This opinion is based on the fact that the anomalies are not removed by dilution, although they disappear completely in presence of boric acid or when the acid is converted into tartar emetic, $KSCO(C_4H_4O_6)$. T. M. L.

2260. *Photography in Science, Industry and Medicine.* **T. T. Baker.** (Roy. Soc. Arts, J. 72. pp. 495–504; Disc., 504–505, June 13, 1924.)

2261. *Law of the Decrease of Fluorescing Power as a Function of the Concentration.* **F. Perrin.** (Comptes Rendus, 178. pp. 1978–1980, June 10, 1924.)—The solution under examination is in a fairly deep vessel, and the exciting light falls normally upon the surface. The fluorescent light is observed through a screen which is opaque to the exciting beam, so as to avoid parasitic effects. The relative intensities of the incident and fluorescent light are measured for different concentrations. The concentrations yielding the maximum ratio are given for seven typical materials. It is shown by argument based upon probability that $F = F_0 e^{-kc}$, where F is the flourescing power for a given concentration, c and F_0 is the limit to which the fluorescing power approaches as c tends to zero. Considering a thin layer of solution, the total fluorescence will be proportional to ce^{-kc}, and will thus be a maximum for the concentration $c_m = \frac{1}{k}$. Thus, finally, $F = F_0 e^{-c/c_m}$. This exponential law is well satisfied by the measurements, which cover a wide range of concentrations. A. A. D.

2262. *Fluorescence of Didymium in Glass.* **N. C. Krishnaiyar.** (Indian Assoc. for Cultivation of Science, Proc. 8. 3. pp. 217–219, 1923.) —When white light traverses didymium glass at ordinary temperatures, the track exhibits bright red flourescence resolved by the spectroscope into four bands of wave-lengths 475–504, 548–560, 588–612 and 622–645 $\mu\mu$. Some observations on the state of polarisation of the fluorescent light are recorded. W. V. M.

2263. *Polarisation of Fluorescence of Dye-stuffs.* **E. Gaviola** and **P. Pringsheim.** (Zeits. f. Physik, 24. 1. pp. 24–36, 1924.)—Method of measurement of the degree of polarisation of a beam of light by means of a compensating pile of glass plates. Examination of the fluorescent light from glycerine solutions of dye-stuffs under the incidence of plane polarised light; the degree of polarisation depends greatly on the concentration. When the polarisation is strong, the correction for multiple reflection increases rapidly with the degree of polarisation. In viscous solutions the degree of polarisation is practically zero for concentrated solutions, and approaches a constant value as the concentration diminishes, which constant value depends upon the viscosity. In anhydrous glycerine 45 per cent. of the light may be polarised; in aqueous solutions at low temperatures, though the viscosity may be much greater, there are no such high figures observed. The depolarisation at high concentrations may be traced, not to re-absorption by the solution (as in resonance-radiation of gases), but to disturbances of closely neighbouring molecules. A. D.

2264. *Optical Properties of Fluorescent Rhodamin B.* **A. Poritsky.** (Frank. Inst., J. 197. pp. 527–539, April, 1924.)—The absorption coefficient of rhodamin B solutions as a function of thickness and concentration was investigated, a Lummer-Brodhun spectrophotometer being used. The dependence of fluorescence upon previous exposure to heat and light was also examined, and the metallic reflection of a film of rhodamin as a function of wave-length was investigated. It was found that the value of the coefficient of absorption for any wave-length is the same, whether the transmitted light is monochromatic or comes from a continuous spectrum source. Rhodamin strictly obeys Lambert's law. Within the observed limits there was direct proportionality between concentration and absorption. With increase in concentration the maximum of the energy distribution of the fluorescent band shifted from $\lambda = 567\ m\mu$ to $\lambda = 583\ m\mu$. Further increase in concentration had no effect. Heat and intense light caused a shift of the maximum of the fluorescent intensity from $573\ m\mu$ towards $564\ m\mu$. The absorption band of a dry rhodamin film is situated in the same part of the spectrum as the solution from which it comes, but, unlike the solution, it possesses an intense metallic reflection. J. J. S.

2265. *Polarised Fluorescence Light.* **A. Carrelli.** (Accad. Lincei, Atti, 33. i. pp. 21–23, Jan. 13, 1924.)—Results confirmed of Weigert and Schmidt (Phys. Zeits. 23. pp. 232–233, 1922) as regards the influence of the solvent on the polarisation of the light emitted on fluorescence of a solution. The light starts as polarised light from the particle impinged upon, and the polarisation does not depend upon any dichroism of the solution or upon any phenomenon of luminous diffusion. A. D.

2266. *Fluorescence of the Alcaloids.* **E. Bayle** and **R. Fabre.** (Comptes Rendus, 178. pp. 2181–2183, June 23, 1924.)

2267. *The Radiation from Combustible Gases and its Practical Determination.* **A. Schack.** (Zeits. techn. Physik, 5. 6. pp. 267–278, 1924.)—Experimental results show that the radiation from certain gaseous bodies approximately increases with the temperature in accordance with Planck's radiation law. A method is devised for the estimation of the radiation from gaseous bodies. With the help of known measurements of the absorption spectra and the total absorption of carbon dioxide and water vapour, formulæ are deduced for absorption. From these approximate formulæ are derived for the calculation of the radiation from gaseous bodies containing carbon dioxide and aqueous vapour. S. G. B.

2268. *Spectrophotometric Definition of Colours of Fluorescence.* **H. George** and **E. Bayle.** (Comptes Rendus, 178. pp. 1895–1897, June 2, 1924.)—A large number of bodies show considerable fluorescence when exposed to the ultra-violet radiation of a mercury arc, and in order to define the fluorescent radiation completely it is necessary to give for each substance a measure of the intensity of the light emitted under given conditions of excitation and to define the colour of this light. The authors propose to define the observed fluorescence by drawing a curve of the distribution of intensity in the normal spectrum (the light of the sun being taken as a standard), and the intensities being referred to the sensation which they produce in the human eye.

The fluorescent spectrum is studied with the aid of a spectrophotometer, thus obtaining a curve (1) giving for each value of λ the ratio of the intensity of the fluorescent light to the intensity of white light taken as standard. By convention, all the radiations composing white light have unit intensity, and hence white light is represented by a straight line parallel to the axis of λ. Thus curve (1) gives at each point the intensity of the fluorescent radiation. The curve is now drawn showing the sensitiveness of the human eye as a function of λ, and by multiplication of each ordinate with that of curve (1) for the same λ a third curve is obtained having the required properties. The area below this curve is evidently proportional to the total luminous intensity. W. V. M.

2269. *Series-Spectra.* **G. Wentzel.** (Phys. Zeits. 25, pp. 182–183, April 15, 1924.)—In previous work [Abstract 275 (1924)] the author had concluded that the series mp', md' in alkaline-earth metals must, if they existed, be different from the series mp, md. At the time he knew only two p' terms and one d' term, and it was doubtful whether the two p' terms belonged to the same series. Meantime A. del Campo (*Trabajos del Laboratorio Fisico*, No. 68, Madrid, 1923, schema [3], p. 43) has found a third group, pp', which appears to belong in series to the two Götze groups pp'. Simultaneous jumps of both series electrons are not uncommon. Various data can be reconciled by assuming that when 2(N) electrons jump, Δk (k being the azimuthal quantum) must on the average be unity for each electron, so that together $\Delta k = 2(N)$; for Ca, $\Delta k = 2 + 0$; for Ne, $\Delta k = 1 + 1$. From this point of view, the second valency-electron might be in a path 4_2 instead of 3_3; we might then have p'', d'' terms, representing jumps from the 4_2 path to the 4_1 or the 3_3. The author is disposed to consider the $3p'$ Ca term of the Paschen-Götze tables (*Seriengesetze der Linienspektren*, Berlin, 1922, pp. 75–76) as a $2p''$ term, with both valency-electrons in the 4_2 orbit; and one of del Campo's series of lines (λ = 6500 Å.) as a combination $2p - 3d''$. A. D.

2270. *Light Radiation and Total Radiation of Wolfram.* **E. Lax** and **M. Pirani.** (Zeits. f. Physik, 22. 5. pp. 275–285, 1924.)—When it is possible to determine experimentally the emission capacity of a substance with sufficient accuracy for all temperatures and wave-lengths which are to be considered, then the connection between the amount of light radiated outwards from it per unit surface (in Hefner candles) on the one hand, the total energy (in watts) on the other hand, and the temperature can be established; that is, the magnitudes $HK_0/(mm)^2$ and $W/(mm)^2$ are, when conditions remain the same, definite functions of the temperature, just as the magnitude W/HK_0 (into which the magnitude of the surface area does not enter), which is called "specific consumption" in the technical phraseology relating to glow-lamps for the particular temperature of the luminous body. Once these connections are established for a material under determined conditions (*e.g.* for vacuum), then glow-lamps under definite arrangements can be made use of as temperature norms in which are measured at the same time their light power and energy. The manifold applicability of this simple method of temperature determination has led to many investigations based upon it, and the authors in this paper deal with the material wolfram, and have investigated the connection between $HK_0/(mm)^2$, $W/(mm)^2$, W/HK_0, and black and true temperatures. In a table the connection between these various magnitudes is exhibited in the red and green region of the spectrum. The connection between $HK_0/(mm^2)$ and the true temperature agrees well with the result obtained by Fosythe in 1923. Comparison is also made with the values obtained by Worthing and Hyde. Curves are given in a diagram which show the relation between W/HK_0 and the temperature for a lamp with wolfram wire with large crystals.

[*Note.*—The quantity W/HK_0 is denoted by 0·080 W/HI*m* and 0·088 W/I*m* in American units.] J. J. S.

2271. *The Origin of the First and Second Positive Groups of the Band Spectrum of Nitrogen.* **M. Duffieux.** (Comptes Rendus, 178. pp. 1966–1968, June 10, 1924.)—It had been shown previously [Abstract 1176 (1924)] that the first positive group is emitted by the molecule and the second positive group by the atom. This result is in accord with the work of Fowler and Strutt [see Abstract 1339 (1911)]. In order to confirm these results atomic nitrogen is obtained in an electric discharge through NO and NO_2, the spectrum being examined as the gas flowed down the discharge tube.

The evolution of the spectra emitted by the gas and the position of the first and second positive groups are, in both cases, perfectly in accord with their supposed origin in the molecule and atom of nitrogen respectively. The dissociation of the oxides at their entry producing atomic nitrogen, the spectrum of this dissociating gas only contains atomic bands to the exclusion of those belonging to molecules. The latter appear on the recombination of the atoms. The case of nitrogen peroxide, whose dissociation is accompanied by an intense atomic emission, appears to show that the breaking up of the molecule and the return of the atom to its atomic equilibrium as an isolated unit, are in this case the effective cause of the emission of the second positive group. W. V. M.

2272. *The Spectrum of Mercury below the Ionization Potential.* **J. A. Eldridge.** (Phys. Rev. 23. pp. 685–692, June, 1924.)—When mercury vapour is bombarded by electrons of energy below the ionising potential 10·4 volts, previous spectroscopic investigation has detected the emission of only the lines $1S - 2p_2$ and $1S - 2P$, whereas according to the Bohr theory, there are many other lines which correspond to changes of orbit involving less energy change than 10·4 volts, which should be emitted line by line as the impacting energy is increased so as to be sufficient to take the electrons to the proper orbits. The failure to observe these lines is now shown to be due to the effect of space charge in lowering the energy of the impacting electrons except at the immediate surface of the anode, and by focussing light from the surface of the anode on to the slit of a quartz spectrograph, spectrograms have been secured showing the development of the spectrum of mercury in the stages predicted by the theory and at approximately the theoretical voltages. At 7 volts only $1S - 2p_2$ appears; at 8·4 volts four new lines due to electrons returning from the 2S or 2*s* levels, at 8·9 volts eight new lines due to electrons returning from the $3d_1$, $3d_2$, $3d_3$, 3D levels; at 9·9 volts sixteen more lines, etc., in full agreement with the theory and with the photoelectric experiments of Franck and Einsporn. AUTHOR.

2273. *New Spectra Emitted by a Neutral Atom of Lithium.* **M. Morand.** (Comptes Rendus, 178. pp. 1897–1899, June 2, 1924.)—To the previously determined lines of the spectrum of neutral lithium [see Abstract 2090

(1924)] must be added λλ4256, 4244, 4187, 4066, 4053, 3841, 3818, 3756, 3653, 2808, 2525. The lines 5488, 4244, 3841, 3652 form a series in which the difference of the wave numbers of consecutive terms is nearly equal to that which exists between the terms of the diffuse series of the arc spectrum of lithium. The constant R has the same value, but "*d*" is different. The formula ($2p - md$), representing the two series, differ in the values of $2p$. If the series $2p - ms$ is considered, 4814, 4053 and 3756 are the second, third and fourth lines.

The author considers that these additional results are in agreement with his previous supposition that two forms of lithium (para- and ortho-) exist, para-lithium emitting the ordinary spectrum and ortho-lithium emitting a slightly different one. The "levels" of ortho-lithium correspond to smaller energies than the levels of para-lithium, and it is supposed that the two circulating electrons are nearer together in para-lithium (where they exist in two one-quantum orbits), and much farther apart in ortho-lithium (one orbit being a one-quantum orbit and the other a two-quantum orbit). It is thought that the two K electrons in atoms of higher atomic weights will show similar variations, and hence it may be possible to explain certain K lines observed in the X-ray spectra of heavy elements. **W. V. M.**

2274. *Structure of the Second Positive Band of Nitrogen.* **R. Mecke** and **P. Lindau.** (Phys. Zeits. 25. pp. 277–278, June 1, 1924.)—In each of nine bands out of a total of forty-four 200–250 lines have been measured by Lindau and the results analysed by the authors. Each band is composed of two sets of three branches, called P_1, P_2, P_3 and R_1, R_2, R_3 respectively. The R_1 and P_1 branches are doublets; where these are not resolved, they fade off on the side of the component of least intensity. The R_2 and P_2 terms are simple, and each alternate line is displaced. The R_3 and P_3 terms are also single, but are not displaced. The relations

$$R_i(m) = F_i(m) - f_i(m-1)$$
$$P_i(m) = F_i(m) - f_i(m+1)$$

are used, where $i = 1, 2, 3$ . . . This leads to a consistent scheme for all the bands. **A. C. M.**

2275. *Pole-effects and Pressure-shifts in the Lines of the Spectra of Zinc and Calcium.* **R. E. Harris.** (Astrophys. J. 59. pp. 261–273, June, 1924.)—A 21-foot concave grating with Rowland mounting was employed, and the photographs were made in the second-order spectrum, where the dispersion was 1·32 Å. per millimetre. The description of apparatus is accompanied by detailed diagrams.

The Pole-effects and Pressure-shifts of the Series Lines of Calcium and of Calcium Chloride.—In all series both types of shift were found to be proportional to a power of the frequency. The pole-effect differed in the two sources, being greater at the positive pole in calcium and greater at the negative pole in calcium chloride.

The Pole-effect in Zinc Lines from Zinc, Brass and Zinc Chloride.—A difference in the pole-effect in the zinc lines due to different sources, zinc and zinc chloride, similar to the difference for the metal and salt of calcium, was found. The pole-effect at the positive pole of the brass source changed greatly with changes in the current. The shifts due to pole-effect and pressure were similar. Shifts of the series lines were found to vary also with the frequency. Tables of the pole-effects for the zinc lines are given. **Author.**

2276. *The Emission Spectrum of Organic Compounds.* **W. H. McVicker, J. K. Marsh** and **A. W. Stewart.** (Am. Chem. Soc., J. 46, pp. 1351–1358, June, 1924.)—Owing to the disruptive effect of the ordinary spark discharge upon the vapours of organic compounds, it has hitherto been impossible to obtain characteristic emission spectra from the majority of carbon derivatives; for as a rule only the spectra of carbon, its oxides, or cyanogen are observed, which result from the decomposition of the compound under examination. The authors [see Abstract 1382 (1923)], however, showed that it is possible to obtain a series of well-marked emission spectra by the use of a Tesla transformer and a quartz spectrograph.

An examination has been made of the Tesla-luminescence spectra of a number of organic compounds belonging to various classes, and it has been shown that, while each compound yields its own characteristic spectrum, the members of a given class show a general resemblance in the spectra which they emit. It has been found that slight changes in structure make their influence felt in the Tesla-luminescence spectra. A study of some heterocyclic compounds indicates that while furfurole, thiophene, pyrrole and pyridine emit no characteristic spectra of their own, the pyridine nucleus exerts a very marked influence when it is fused with a benzene ring, as in quinoline; the reduction of the pyridine structure produces a marked alteration in the spectrum of the compound. **W. V. M.**

2277. *The Stark Effect in Hydrogen and Helium in Fields up to 38 kv./cm.* **J. S. Foster.** (Phys. Rev. 23. pp. 667–684, June, 1924.)—The lo Surdo method was improved by using a rotating cathode to minimise pitting. A three-prism glass spectrograph and a Hilger quartz spectrograph E_1 were used. Enlargements of the spectrograms for H_γ and for six He lines are given. (1) *Hydrogen Balmer Lines.*—At fields below 3 kv./cm. the red side of each line is more diffuse than the violet side, in agreement with Kramers' theory of the connection between the Stark effect components and the fine structure components. For fields above 5 kv./cm. ten *p* components of H_γ are symmetrically arranged, the ratios of $\Delta\lambda$ to field coming out $\pm$ (0·230, 0·191, 0·153, 0·065, 0·026) A/kv./cm. Changes in the relative intensities of components of H_γ and of H_δ with increasing field are noted, and the observed relative intensities of H_ϵ are found to agree fairly well with Kramers' theoretical predictions. (2) *Parhelium Lines.*—Measurements at five-field strengths are given for the groups near the D lines 4388, 4144, 4009, and near λ3614, including some new components. The number of lines in each group increases with the order. Combination series of the type $2P - mQ$, $2S - mQ$ ($Q = S, P, B, E, F \ldots; M = 4, 5, 6 \ldots$) are suggested which include these lines and also the components of Stark's "diffuse principal" series, and which fit into the scheme proposed by Tschulanowsky. The variable behaviour of lines near λ4388 in low fields is noted, and observations are given for the λ3927 group. As a rule the Stark effect pattern is constant for the members of each series, but varies with the series. Many components vanish with increasing field. (3) *Ortho-helium Lines.*—Measurements are given for groups λ3820 and λ3705 and observations for λ4026. **Author.**

2278. *The Absorption Coefficients of Homogeneous X-Rays between Wave-lengths 0·1 Å. and 0·71 Å.* **S. J. M. Allen.** (Phys. Rev. 24. pp. 1–8, July, 1924.)—Using the general radiation from a tungsten target, dispersed by reflection from a crystal, the total mass absorption in fourteen elements of atomic number 6 to 83 (C, Mg, Al, S, Fe, Ni, Zn, Ag, Sn, W, Pt, Au, Pb and Bi) was determined for various wave-lengths from 0·10 Å. to 0·51 Å. by the ordinary ionisation measurements. The K_α and K_β radiation from a Mo target was used to give values for wave-lengths 0·63 Å. and 0·71 Å. Very good agreement was found with the results of Richtmyer and Duane wherever these are comparable. For the elements from C(6) to W(74) the results are represented within a few per cent. by the formula $\mu/\rho = \tau/\rho + \sigma/\rho = C\lambda^{2 \cdot 92}N^{2 \cdot 92} + \sigma/\rho$, where $C = 7 \cdot 82(10)^{-3}$ for the K absorption and $1 \cdot 00(10)^{-3}$ for the L absorption and the scattering coefficient σ/ρ is assumed to increase with N from 0·144 for Al to 0·50 for W at 0·12 Å., and also with the wave-length. The jump in the value of the fluorescent absorption coefficient τ/ρ from L to K absorption is the ratio of C_K to C_L, or 7·8. The atomic absorption $\tau_a = 2 \cdot 18(10)^{-26}\lambda^{2 \cdot 92}N^4$ (Bragg-Owens law). For the heavier elements Pt, Au, Pb and Bi the values of C_K get progressively lower to $4 \cdot 7(10)^{-3}$, and those of C_L increasingly higher to $1 \cdot 12(10)^{-3}$, the ratio or jump decreasing to 4·1 for Bi. AUTHOR.

2279. *The K and L Absorption and Emission Spectra of Tungsten.* **C. B. Crofutt.** (Phys. Rev. 24. pp. 9–15, July, 1924.)—Both the absorption and emission spectra were photographed simultaneously on the same plate, using a special float-operated mechanism to turn the crystal very slowly so as to obtain the faint lines between β_2 and β_5. The *absorption wave-lengths* were found to be: LA_1, 1·2122 A; LA_2, 1·0716A; LA_3, 1·0217A; KÅ, 0·17802A. The *emission wave-lengths* of 28 L emission lines are given, including the four new lines β_{15} (1·2432), β_{16} (1·2166), γ_{12} (1·0748) and n (1·0699), and of the $K\beta_3$ line (0·18525), which is the line found by de Broglie. *Comparison with the Bohr Theory.*—The agreement of the emission frequencies computed from the energy levels with the measured wave-lengths is better than 1/10 per cent., except for β_{15} and β_{16}. The lines β_{10}, β_9, γ_{12} and γ_{11}, however, correspond to transitions between energy levels which are not predicted by the selection principle, and lines β_8 and n are not in agreement with the accepted energy levels. While Ln may be due to an impurity, β_8 is probably a tungsten line. AUTHOR.

RADIO-ACTIVITY.

2280. *The Estimation of Radium, Mesothorium and Radiothorium in a Mixture by Means of γ-Rays.* **W. Bothe.** (Zeits. f. Physik, 24. 1. pp. 10–19, 1924. From the Reichsanstalt.)—The method employed, which takes advantage of the different coefficients of absorption of the γ-rays of these elements when sent through a lead filter, has been used by Hahn, who employed filters up to 4·5 cm. thick. The author has improved the experimental conditions by employing a series of much thicker filters and a very sensitive measuring device, with which the γ-rays penetrating through them can be measured. A series of four concentric lead cylinders was made use of, in the common axis of which the radio-active preparation was placed; the total possible thickness of lead being 11 cm. The ionisation chamber was a cylindrical ring-shaped vessel surrounding the lead cylinders, and had a ring-shaped electrode of sheet iron concentric with the walls of the chamber. Curves were obtained for a number of different preparations, showing the radium equivalent, A, as a function of the filter thickness, by measuring for each thickness the velocity of fall of the gold-leaf of the electroscope, first for the preparation and then for a normal radium preparation, the normal value of which through 0·5 cm. of lead was taken as unity. Curves are given for pure radium, pure radiothorium, old mesothorium preparations containing radium, in which a considerable amount of RaTh has formed, fresh mesothorium preparations separated from the old preparations, and containing a great deal of radium, and one containing very little radium; finally a curve is deduced for pure mesothorium from the above, and another for a mixture of the three substances, in which for three different thicknesses the radium equivalent is unity, but which rises above the pure radium line, drops below it, and then again rises above it as the thickness goes on increasing. The curve for each of the pure substances is so distinctive that, with very few exceptions, it is possible from the form of curve of a mixture to deduce the proportions of the three constituents. H. N. A.

2281. *The Number of α-Particles Ejected by Radium.* **V. F. Hess** and **R. W. Lawson.** (Zeits. f. Physik, 24. 5–6. pp. 402–410, 1924. Phil. Mag. 48. pp. 200–207, July, 1924.)—The authors criticise the results of Geiger and Werner [Abstract 1203 (1924)], and conclude that the larger number obtained by the present authors in 1918 is more reliable. It is probable that the platinum of the cone-shaped emanation container employed by Geiger and Werner, which was heated during the filling process, occluded emanation when it cooled, and so reduced the number of scintillations observed. A discrepancy of 10 % could easily be produced in this way. Geiger and Werner were not justified in assuming that the phosphorescent screen was almost perfectly efficient in recording the α-particles; the mixture of oil with the zinc sulphide particles for forming the screen very possibly diminishes the efficiency of the latter substance. The method of arriving at the true number of scintillations from the observations of three observers is also criticised. Replying to a remark of Geiger and Werner, the authors call attention to the fact that their own final result is not deduced from the photographic registration, as Geiger and Werner assume, but from numerous subjective counts, in which the mean value of the electrometer deflection was ten divisions, and that no disturbances greater than 0·5 divisions were observed; these were due to vibrations caused by passing carts, etc. A calculation of the number of α-particles per gramme of radium per second from the amount of heat produced by radium gives $Z = 3{\cdot}83 \times 10^{10}$, as compared with Geiger and Werner, $Z = 3{\cdot}4 \times 10^{10}$, and the authors, $Z = 3{\cdot}72 \times 10^{10}$, a difference of 10 % between values 1 and 2 and of only 3 % between 1 and 3. Geiger and Werner conclude that in the disintegration of radium, besides the kinetic energy of the α-particle and of the recoil atom, additional energy is liberated as a result of the rearrangement taking place in the nucleus. Reasons are given for concluding that, while this may account for the difference in the first and third values for Z, it is improbable that it can account for the very much larger difference between the first and second. H. N. A.

2282. *Secondary Radiation Due to γ-Rays.* **D. Skobelzyn.** (Zeits. f. Physik, 24. 5–6. pp. 393–399, 1924.)—Observations have been made, visually and photographically, of the electron paths produced in a Wilson cloud chamber by the passage of a beam of γ-rays from radium. The paths were several cm. long, and the corresponding velocity is far smaller than that to be expected from the Einstein equation for a photoelectric effect of the γ-rays on the electrons; the directions of the electrons did not, in general, agree with the directions of the γ-rays, but were often nearly perpendicular to them. Wilson observed some very short tracks using hard X-rays ("sphere tracks" and "fish tracks"), but it was not possible to decide as to their direction with respect to the X-rays producing them; both phenomena are explainable as the result of the recoil of the electron, due to the scattering of an energy quantum. As far as Wilson's observations go it is possible to assume that the scattering takes place in the form of a spherical wave; but the observations with the γ-rays, which have a much higher energy quantum than Wilson's X-rays, and which give the electrons much higher velocities, so that they produce much longer tracks, contradict this assumption, and appear to agree much better with the Debye-Compton theory of scattering.

H. N. A.

2283. *The Number of γ-Rays Emitted per Second from Radium B and C per Atom Disintegrating.* **A. F. Kovarik.** (Phys. Rev. 23. pp. 559–574, May, 1924.)—The γ-rays struck the metal window front of a Geiger counting chamber, and produced β-ray emissions. It was assumed that each γ-ray quantum caused the emission simultaneously of one or more β-particles, and these simultaneous emissions were counted, using an automatic registering device. Different thicknesses of different metals were used for the counter front, and the coefficient of absorption of the β-rays in the metal was found by determining the thickness of front which gave the maximum number of counts, by means of an equation derived in the original paper. Corrections for scattered γ-rays, and for β-rays from the walls of the chamber, were determined experimentally; and the coefficient of absorption of the γ-rays was determined from corrected counts, with different thicknesses of absorbing metal placed near the source, between it and the counting chamber. The total number of emissions which would have been produced, if all the γ-rays from RaB and RaC had been absorbed in the metal, was determined for Al, Cu, Sn, Pt and Pb, and was found the same for all, with a mean variation of ± 3 %, being $7\cdot28 \times 10^{10}$ per gramme of radium in equilibrium with its disintegration products. This is equal, within the limits of experimental error, to twice $3\cdot57 \times 10^{10}$, which is the number of atoms of each of the two elements disintegrating per second; and it is deduced from this that each radio-active transformation results in the emission of a γ-ray entity, which sooner or later produces a β-ray emission from a single atom. With the hard γ-rays, capable of penetrating 1·55 cm. of lead, the number of counts were 76 % of the total with all the γ-rays; ionisation experiments gave about 73 %, the smaller figure being due to the smaller ionising power of the fast β-rays; the result with the first method is regarded as the more significant. The original paper contains a full treatment of the somewhat complicated theory of the method.

H. N. A.

HEAT.

2284. *The Determination of the Temperature of Opaque Diffusively Reflecting Bodies.* **M. Pirani.** (Zeits. techn. Physik, 5. 6. pp. 266–267, 1924.)—A method is afforded for the measurement of the reflecting power at high temperatures, and on the basis of the results obtained with chromium oxide the range of an earlier used method is extended. An image of a glowing or incandescent surface, *e.g.* the anode of a tungsten or carbon arc, is projected upon a plate whitened with a covering of magnesium oxide. The surface intensity of illumination of the plate at the point where the image is found is measured by the determination of the apparent temperature with a Holborn-Kurlbaum pyrometer. The magnesium oxide covered plate is then removed, a plate of the material to be measured is substituted and the readings duly recorded.
S. G. B.

2285. *The Determination of High Temperatures.* **F. Henning.** (Zeits. Elektrochem. 30. pp. 309–318, July, 1924. Paper read before Deut. Bunsen. Gesell., Göttingen, June, 1924.)—The paper describes a new form of optical pyrometer designed for the measurement of high temperatures by means of radiation. For non-black body radiation the method used measures a "pseudo-temperature" which is defined as the temperature which a black body would have if all its observed radiation characteristics showed the same sum total as the non-black body radiation, *i.e.* it is the temperature at which a black body would possess the same total radiation, the same maximum energy for a definite wave-length, the same intensity of illumination, the same colour, the same intensity of radiation for a definite wave-length. The relation between this "pseudo-temperature" and the actual temperature is deduced and the expression given for the same. The chief characteristic of the pyrometer is that an image of the source to be measured, magnified five times, is formed at the filament of the standard lamp. These are both again magnified 4·5 times by means of an eye-piece lens, so that the source is magnified 22·5 times. A colour screen (red) was placed in front of the eye-piece. Thus extremely fine incandescent filaments or small holes in radiant bodies can be measured, and these have been used of the order of 0·2 mm. in diameter. The special characteristics of the pyrometer are discussed, and its use for the determination of the melting-point of tungsten is given. The value so found was $t = 3370° \pm 50°$ C. The method was also used for the measurement of temperature of transparent radiant bodies. The question of colour temperatures is discussed and the various equations connected thereto are deduced. The standardisation of the instrument is described and the temperature of the melting-point of platinum determined. The paper concludes with a note on colour temperature and its application to astrophysics. Star temperatures can thus be determined according to instructions given. S. G. B.

2286. *The Determination of the Conductivity for Heat of Technical Materials.* **O. Tesche.** (Zeits. techn. Physik, 5. 6. pp. 233–236, 1924.)—The method used is illustrated diagrammatically and is an adaptation of that proposed by Christiansen (Wied. Ann. 14. p. 23, 1881). Several round copper plates of diameter 8·6 cm. and thickness 0·8 cm. are laid upon each other separated by small, flat glass slabs. The uppermost plate is a double one, and a spiral heating coil is inserted between the layers and carefully insulated. The two spaces between the other copper plates are filled with a substance of known conductivity and the material under test respectively. The temperature gradient is determined by means of copper constantan thermocouples specially calibrated before insertion into recesses in the copper plates. The lowest plate is maintained at 0° C. by means of a special thermostat arrangement, and the whole apparatus is screened from radiation and kept in a room maintained at constant temperature. A discussion of the formula employed and the sources of error is given and the results embodied in a table giving values for the conductivity for rubber, gelatine, celluloid, graphite, etc. Water was used as the substance of normal conductivity. S. G. B.

2287. *Convective Cooling of Wires in Streams of Viscous Liquids.* **A. H. Davis.** (Phil. Mag. 47. pp. 1057–1092, June, 1924.)—The author discusses theoretical formulæ and chooses as a basis the general expression :—

$H/k = F(Vdc/k\ ;\ k/cv)$ where

H = heat loss per unit time per unit length of the wire per degree temperature elevation.

k = thermal conductivity of the fluid.

c = specific heat of the fluid per unit volume.

ν = kinematical viscosity of the fluid $= \eta/\rho$.

V = velocity of the fluid stream.

d = diameter of the wire.

The effect of the k/cv term was experimentally investigated. The apparatus consisted of a motor-driven whirling arm which carried the test-wire with its length vertical, and forced it continually through the liquid contained in an annular circular trough 242 cm. in circumference. Observation was made of the temperature of the wire and of the electric energy required to maintain a measured temperature difference between the wire and the general body of the liquid. Wires of specially pure platinum about 4, 6 and 8 mils diameter and about 4·8 cm. long were used. The liquids used were distilled water, paraffin and three transformer oils, of which the most viscous resembled olive oil at 15° C.

The author found that the above formula was fairly satisfactory, except that a factor must be included to cover certain small residual effects. It was found that the function F could not be represented by the product of two independent terms in Vdc/k and k/cv respectively, but that each influences to some extent the effect of the other. The following form was found to be satisfactory :—

$$H/k = Rf(k/cv)F\{(Vdc/k) \times (k/cv)^{\frac{1}{2}}\}$$

where R represents the residual factors referred to. An estimate was made of the velocity of the natural convection current set up by the heated wire. Tables and curves are given showing heat losses obtained with each of the liquids. W. C. S. P.

2288. *Forced Convection of Heat in Gases and Liquids. Part II.* **C. W. Rice.** (Indust. and Eng. Chem. 16. pp. 460–467, May, 1924.)—

A companion paper referred to in Abstract 890 (1924). In the present paper the writer develops a more general expression for the effective film thickness by the method of dimensions. The paper is unsuitable for abstracting. E. G.

2289. *Thermal Diffusivity and Conductivity of Some Soil Materials.* **L. R. Ingersoll** and **O. A. Koepp.** (Phys. Rev. 24. pp. 92–93, July, 1924.)—Thermal diffusivities of certain soil materials, quartz sand, sandy clay, calcareous earth and packed snow have been determined by a method based on the principle of linear heat flow in a slab whose faces are suddenly chilled. The material was packed in a narrow sheet copper box having broad faces, with a resistance thermometer in the centre. After standing at room-temperature for two days it was placed in stirred ice-water and the time required for the temperature to fall half-way to zero noted. This allowed direct calculation of the diffusivity, and from a knowledge of the density and specific heat, of the conductivity. AUTHORS.

2290. *Measurement of the Specific Heat C_v of Gases by the Differential Method. Part II.* **M. Trautz** and **K. Hebbel.** (Ann. d. Physik, 74. 4. pp. 285–324, June, 1924.)—The method was employed two years ago by Trautz and Grosskinsky [Abstract 705 (1923)], and their results were so promising that the construction of better apparatus which would allow the question of the accuracy and definiteness of the results to be settled seemed desirable. The greatest source of error in all previous measurements of the specific heat of gases arose from the uncertainty of the magnitude of the quantity of heat given to the enclosure compared with the heat capacity of the gas. In any new method this heat exchange must be made as small as possible. This can be achieved by making the gas act as its own protector and at the same time its own thermometer. The heat is given to the gas in the form of a " heat-cloud," and is obtained from very thin platinum foil connected in the secondary circuit of a transformer when the primary circuit is broken. The gas to be experimented on is contained in a flask connected by a manometer to another vessel of the same size (the measuring vessel). If the same amount of energy is given to each vessel, the manometer is not disturbed. If the gas in the first flask is replaced by another gas and energy supplied, the manometer is disturbed, but it can be restored to equilibrium by changing the volume of the measuring vessel; this is accomplished by a known quantity of oil. If the specific heat of the gas in the measuring flask is known, the ratio of the two volumes in the measuring flask gives the ratio of the specific heats of the two gases in the gas flask. For the gas with known specific heat pure CO_2 was employed. The necessary equations are written down, and the final result obtained is

$$C_{vM} = C_{vV} \cdot \frac{V'_2}{V'_1} \cdot \frac{n''_1}{n''_2} \cdot \frac{\beta_2}{\beta_1}$$

for this equation to hold $Q'_1 = Q'_2$ and $Q''_1 = Q''_2$. These conditions are discussed and tested later in the paper.

C_{vM} = specific heat of gas in gas flask; C_{vV} = specific heat of gas in measuring flask; V'_1 = volume of comparison gas in measuring flask; V'_2 = volume gas to be experimented on in measuring flask; n''_1, n''_2 molecular numbers of the two gases in gas flask; β_1, β_2 the pressure-coefficients of the two gases. The essential condition for the fulfilment of the above equation is that the gas thermometer gives the true mean temperature of the whole gas. The condition for this is that the temperature of the heat-cloud only exceeds that of the surrounding gas by such a small amount that the specific heat of the portion of gas in the cloud is only altered by such an amount that it cannot be detected by the differential method. In the new experiments arrangements were made to secure (1) temperatures up to 600° C. This necessitated two thermostats, one for the measuring vessel and the other for the gas flask; the former was a water thermostat and the latter an electric oven. (2) Sufficient height of the gas flask to prevent the heat-cloud from reaching the top before the measurements could be obtained. (3) That the material of the flask was not acted upon by the gas. (4) That the heating body could be easily replaced by another of different material, and was capable of movement in order to investigate the properties of the cloud. A full description of the construction of the various parts of the apparatus follows, with diagrams. The question as to the fulfilment of the principle of the method in the investigation and as to the definition of the temperature measured is next considered, and the properties of the heat-cloud are investigated by means of a pressure-time curve. The necessary and sufficient conditions for the existence of a free hovering cloud are: (1) The heater has completely given up its energy before the first heat energy is given out at any part of the wall of the containing vessel independent of any due to a diabatic work performed by the cloud. (2) Since the cloud rises with a definite velocity when the energy supply is kept constant, a shortening of the distance between heater and wall of vessel must show itself on the pressure curve. These conditions are fully investigated, and the photographic method of recording the pressure time curve is described. The electrical arrangements and working of the transformer, with diagrams, follow, and finally a general discussion of the results obtained and of the data employed in the calculation, *i.e.* the exact value of n_1''/n_2'' and of β_2/β_1, and the purity of the gases used is given, together with a comparison of the results obtained with the new and old apparatus. The final values are:—

CO_2 ...... 6·919 at 14·4° C. limit of error ± 0·15 %.
H_2 ...... 4·809 at 15·6° C. limit of error ± 0·4 %.
H_2 ...... 4·812 at 16·6° C. limit of error ± 0·4 %.
N_2 ...... 4·975 at 22·1° C. limit of error ± 0·2 %.
N_2 ...... 4·975 at 22·5° C. limit of error ± 0·2 %.
N_2 ...... 4·975 at 24·3° C. limit of error ± 0·2 %.

T. B.

2291. *The Connection Between the Specific Heat C_v, the Internal Energy U, and the Equation of State of a Body Based on the Second Law of Thermodynamics.* **W. Jazyna.** (Zeits. f. Physik, 25. 2. pp. 133–135, 1924.)—It is shown for all physical systems which obey the first and second laws of thermodynamics that when $C_v = f(T)$, so also must $U = F(T)$. When such is the case the theorem constitutes a basis for a formal criterion of the equations of state of the body in question. From this standpoint all known equations of state can be divided into three categories: (1) Those which are in accord with the second law, *e.g.* the Clapeyron and Tumlirz; (2) those which contradict the above laws, *e.g.* the van der Waal and the Wohl with constant coefficients; (3) those which may be broadly designated as not contravening the second law, *e.g.* the Clausius, Callendar, Linde, K. Onnes, Eichelberg, etc. H. H. Ho.

2292. *The Specific Heat of Steam.* **H. L. Callendar.** (World Power, 1. pp. 274–280, May, and pp. 325–328, June, 1924.)—The author explains the principles of the recent researches made with steady flow methods of calorimetry, and discusses some of the difficulties encountered in the neighbourhood of saturation, which caused the abandonment of many of the older methods. The energy equation for a fluid in steady flow is given and its application to the throttling and electric calorimeters is explained. The chief feature of the former calorimeter is a porous plug or throttling valve used to reduce the pressure without doing external work. After throttling to atmospheric pressure, the steam may be condensed and its total heat measured from the state of water at atmospheric pressure. In the electric calorimeter an electric heater is included on the circuit between the inflow and outflow thermometers, and the rise of temperature due to a known quantity of electric energy is observed.

A differential method of determining the heat loss is given in which two throttling experiments are performed under the same conditions of pressure, and temperature, but with different values of the mass flow. The advantages of the direct throttling method are reviewed and summarised in the following way: (1) It gives the value of the total heat itself at a high pressure in terms of the value at atmospheric pressure. (2) This relation follows directly from the fundamental equation, and does not require any knowledge of the state at intermediate points or of the variation of the specific heat and the cooling effect with temperature or pressure. (3) The differences of temperature and pressure are large and easily measured, and the external heat loss is relatively small and readily determined by simultaneous observations. Kinetic energy correction and wetness error are discussed, and the importance of design in connection with the former is indicated. Knoblauch's results of direct measurements of specific heat at high pressures are discussed, and curves are given representing the variation of the specific heat at constant pressure at the saturation point, given by different formulæ or methods of calculation. W. C. S. P.

2293. *The Rate of Evaporation of Liquids in a Current of Air.* **T. B. Hine.** (Phys. Rev. 24. pp. 79–91, July, 1924.)—The experiments were made in a large ventilating tunnel at Edgewood Arsenal, near the end of a 280-ft. straight section, 6 ft. square. The liquid being studied was pumped continuously into a copper pan mounted flush with the floor, over the edge of which it overflowed into a lower pan. The amount of evaporation in several hours was determined by weighing the pans. Results were obtained for chlorbenzene, M-xylene, nitrobenzene and toluene, for winds from 0 to 15 miles per hour, 49 runs in all. The rate of evaporation is found to be a linear function of the wind velocity, and taking the values of vapour pressure given in the literature corresponding to the temperatures of the liquid surfaces, the relation suggested by de Heen in 1891 is found to be correct; the number of gram. mols. evaporated per hour from a liquid surface 60 cm. in diam. is given by $M = (0{\cdot}1 + 0{\cdot}10W)P$, where W is the wind velocity in miles per hour and P is the vapour pressure in millimetres of mercury. Due to variations in the wind velocity and uncertainty as to the exact temperature of the surface in some cases, the mean variation of observed values of M from the computed values is about 10 %, but there is no evidence of a systematic deviation of the results for any one liquid, although the vapour pressures vary from 0·3 to 30 mm. AUTHOR.

2294. *Fluid Friction and Heat Transference.* **T. B. Morley.** (Engineer, 137. pp. 596–597, May 30, 1924.)—Describes the construction of nomographic charts for the computation of the frictional resistance to the flow of a liquid in a pipe and the transference of heat between the fluid and the tube wall. E. G.

2295. *The Relation Between the Total Thermal Emissive Power of a Metal and its Electrical Resistivity.* **C. Davisson and J. R. Weeks, Jr.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 581–605, May, 1924.)—Foote has shown that the ratio of the total power radiated per unit area of a metal to the total power radiated per unit area of a black body at the same temperature can be expressed by the formula

$$E = 0\cdot5736(T\rho)^{1/2} - 0\cdot1769(T\rho),$$

where ρ is the resistivity of the metal in ohm-cm. and T the temperature. The authors have been unable to check experimentally the total emissive powers for platinum calculated from Foote's formula. They have therefore developed a formula for the total emissive power of a metal which takes into account the departures from Lambert's law required by Fresnel's laws of reflection. It appears from this formula that the total emissive power of a metal defined in terms of total power radiated is, in general, about 20 per cent. greater than that defined in terms of the intensity of the total emission normal to its surface. The authors' formula for the total emissive power is

$$E = 0\cdot751(T\rho)^{1/2} - 0\cdot632(T\rho) + 0\cdot670(T\rho)^{3/2} - 0\cdot607(T\rho)^2 \ldots$$

Using only four terms of this series the error at $(T\rho) = 0\cdot075$, which is about the value for platinum at 1500° K., is less than 0·5 per cent. The modified formula of Foote becomes

$$E_1 = 0\cdot576(T\rho)^{1/2} - 0\cdot178(T\rho) + 0\cdot044(T\rho)^{3/2} \ldots$$

If a metal at temperature T be immersed in radiation of temperature T_0, then the apparent total emissive power is $E' = E - A_0(T_0/T)^4$, where A_0 is the total absorptive power of the metal and is equal to $f(T_0\rho)$ and can be expressed in terms of the above series. Tests were then carried out on two platinum filaments, one of 16 cm. length and the other of 50 cm., electrically heated *in vacuo*. In each case the apparent emissive power was obtained by dividing the electrical power dissipated in a middle section of the wire by the power that would be radiated from an equal area of perfectly black surface at the same temperature. This value was then compared with the theoretical apparent emissive power calculated from the temperature and resistance of the filament and the temperature of the surroundings by means of the formula given. The object of making tests on two filaments was to obtain a correction for heat lost due to conduction, which is important at low temperatures. Fairly satisfactory comparisons of observed and calculated values have been carried out in the range 300° K. – 1500° K. The discrepancies between the observed and the calculated values are attributed to two causes—a variation of the electrical resistivity of platinum with frequency for frequencies approaching those of the visible spectrum, and to the effect upon the radiation of a natural period of the platinum atom corresponding to a wave-length of about $7 \cdot 5\ \mu$. W. C. S. P.

2296. *The Equations of Movement of a Gas.* **Y. Rocard.** (Comptes Rendus, 178. pp. 1882–1884, June 2, 1924.)—If (u, v, w) are the absolute velocities and (u_0, v_0, w_0) the group velocities of a molecule at the point (x, y, z), $\overrightarrow{V}$ the vector of the components u_0, v_0, w_0, $U = u - u_0$, $V = v - v_0$, $W = w - w_0$, the velocity of A relative to the centre of gravity of the material element of the gas at (x, y, z) at time t, then the equations of motion of the gas as given by Maxwell are

$$\rho\partial u_0/\partial t + \rho u_0\partial u_0/\partial x + \rho v_0\partial u_0/\partial y + \rho w_0\partial u_0/\partial z$$
$$= \rho X - \partial/\partial x(\rho\overline{V^2}) - \partial/\partial y(\rho\overline{UV}) - \partial/\partial z(\rho\overline{UW})$$

and two similar equations. Recent work by Chapman has determined the function of distribution of velocity to the first approximation in the vectorial equation

$$\rho d\overrightarrow{V}/dt + \text{grad } P = \rho\overrightarrow{F} + \frac{\eta}{3}[\text{grad div } \overrightarrow{V} + 3\Delta\overrightarrow{V}]$$

F being the vector of the components X, Y, Z, η the coefficient of viscosity. James (Phil. Trans. A, 233. I, 1922) has carried this to a second approximation. By the aid of James's equation one can derive with respect to the time the circulation Γ along a closed curve C, which is deformed with the fluid, and obtain the equation

$$(d\Gamma/dt)_{t_0} = \int d/dt(\overrightarrow{V}\,.\,\overrightarrow{ds}) = 4\eta/3\int d\Delta\phi/\rho - 8/15(y\eta\vartheta)\int d\Delta T/P\rho$$
$$- 4K\eta^2/3\int(d\Delta/dt)(d\phi/dt)1/P + \text{terms}$$

which disappear under certain assumptions. Assuming an incompressible fluid, the first term on the right disappears, but owing to the presence of P in the other terms they cannot be annulled in general. It is thus deduced that the theorem of Lagrange on the conservation of the velocity potential does not apply.

A method is suggested for determining the initial value of all the differential coefficients which can be written in the successive approximations either in the function of distribution of velocity or in the equations of motion. A simple case is taken of the elastic impact of a molecule falling on a surface without transfer of heat. It is shown that in general a functional equation of a complicated type is obtained, but this can be resolved to Chapman's approximation to a certain number of linear equations which will solve the problem. T. B.

2297. *The Vapour Tension Equation at Low Temperatures.* **V. Fischer.** (Zeits. techn. Physik, 5. 5. pp. 187–192, 1924.)—Kirchhoff's vapour tension equation was derived by Gibbs with the help of the conception of the thermodynamic potential. The Kirchhoff equation, however, assumes a constant specific heat, both for the vapour and for its solid or liquid phase. This assumption has been shown by later experiments to be inadmissible at low temperatures. Gibbs's derivation of the Kirchhoff equation, however, allows of easy generalisation without assuming constant specific heat. In the general equation $TdS = C_v dT + AT(\partial p/\partial T)_v dv$; the specific heat C_v at constant volume can be expressed as a function of the absolute temperature T and of the specific volume v. Integrating this equation the entropy is obtained as $S = \int C_v . dT/T + f(v)$. Assuming that in the liquid or solid phase changes of volume may be neglected, $S = \int C_v dT/T + C$ and the specific heat can be represented by a series similar to a Maclaurin series, thus :—

$$C_v = C_{v_0} + C'_{v_0}T + C''v_0 . T^2/2 + C'''v_0 T^3/6 + \ldots$$

where $C'_{v_0} \equiv (dC_v/dT)_{T=0}$, etc. Hence

$$\begin{aligned} S &= \int [C_{v_0}/T + C'_{v_0} + C''_{v_0}T/2 + \ldots]dT + C \\ &= C_{v_0} \log_e T + C'_{v_0}T + C''_{v_0}T^2/4 + \ldots + C. \end{aligned}$$

Following on these equations, the author develops a long series of equations indicating the behaviour of the substance at low temperatures. The paper is entirely mathematical. T. B.

2298. *Equation of State of a Gas.* **J. E. Jones.** (Cambridge Phil. Soc., Proc. 22. pp. 105–112, May, 1924.)—The approximate equation $pv = kNT + B/v$ where p, v, T are pressure, volume and temperature, and k is the Boltzmann constant, N the number of molecules, and B a constant has been obtained by a number of writers by various general methods. This paper gives two new derivations, which have the advantage of showing the physical significance of the constant B. The author points out that, while the pressure at the boundary of a gas has the same value as that in the interior, they are of different natures. At the boundary the pressure is due entirely to the motion of the molecules, whilst in the interior a part only is due to this cause, the remainder being due to the stress set up by the existence of inter-molecular fields. It is this pressure which appears in the formula as B/v^2, the remainder (kNT/v) being given by the perfect gas law. E. G.

2299. *On the Absolute Value of the Entropy of Real Gases.* **V. Njegovan.** (Zeits. Elektrochem. 30. pp. 291–293, June, 1924.)—This investigation extends an earlier one dealing with perfect gases [see Abstract 522 (1923)] to real gases, such as oxygen and steam. The general form of the entropy equation $S = F(T_1 p) +$ constant is employed with such experimental data as are available. The entropy constant, which is absolute for a perfect gas, is now dependent on other conditions, and the expression assumed is $S = F(T_1 p) + 2 \cdot 3023 \mathfrak{T}(C_p - C_v) + C_p$. The absolute entropy values for different pressures and temperatures are calculated and compared with the corresponding C_v values. Within a certain experimental region there appears a striking proportionality between the absolute entropy and the specific heat at constant volume. An apparent case of contradiction with classical thermodynamics arises, *viz.* a decrease of entropy with an increase of volume, which is found to depend, however, on the conception of the entropy constant. Further investigation is necessary. H. H. Ho.

SOUND.

2300. *Acoustic Disturbance Recorded at Paris Due to the Explosion at La Courtine on May 15, 1924.* **A. Dufour.** (Comptes Rendus, 178. pp. 1741–1743, May 19, 1924.)—The explosion at La Courtine on May 15, 1924, was not heard at Paris, but records obtained from four microphones each showed a disturbance at 19h. 46m. 53s.; the disturbance lasted for about three seconds, and consisted of oscillations of pressure with a period of about one second. The velocity of the disturbance, obtained on the assumption that the explosion occurred exactly at 19h. 30m., is approximately 340m./s. A. W. L.

2301. *Effect at Meudon of the La Courtine Explosions.* **H. Deslandres.** (Comptes Rendus, 178. pp. 1864–1865, June 2, 1924.)—The conditions on the day of the second explosion were less favourable than before; for the third explosion they were still worse. On May 23rd three trains of waves reached Meudon, as follows:—

(1) From 20h. 16m. 35·2s. to 36·0s.
(2) From 20h. 16m. 36·3s. to 37·2s.
(3) From 20h. 16m. 37·5s. to 38·4s.

These waves must be due to the explosion, since during the ten preceding and the ten following minutes the trace of the recorder was absolutely rectilinear, showing no disturbance on account of the wind. On May 25th the wind was stronger, and, in order to permit of a better determination of the air-pressure at the time of passing of the wave, the microphone was less completely protected. Three trains of waves comparable to the previous ones were registered, but these could not be entirely separated from disturbances caused by the wind. G. A. S.

2302. *Zones of Silence.* **E. Esclangon.** (Comptes Rendus, 178. pp. 1892–1895, June 2, 1924.)—The simplest explanation of zones of silence, and in the author's opinion the most probable one, is that they are a result of meteorological conditions at the time. The combined action of temperature and wind produces continuous (or sometimes discontinuous) deviations in the sound waves, and causes their return to the ground, and even the concentration in certain places of the sound energy. The explanation by a reflection in the very high layers of the atmosphere, at an altitude of 80 to 100 km., where the pressure is of the order of a fraction of a millimetre, seems unlikely because of the considerable loss of energy that would be imposed on the sound waves in traversing the double path. Further evidence against this explanation is furnished by the phenomenon of aerolites, which, in spite of the powerful disturbances they produce in the upper atmosphere, are almost always silent to terrestrial observers. Also there is no constant disposition of zones of silence round a source, but these vary with every case. The hackneyed experiment showing how short a distance sound is transmitted in the rough vacuum under the receiver of an air-pump indicates that the low density of the air at high altitudes would be an insuperable obstacle to even the loudest sounds that are produced on the earth. A theory is developed, which, making assumptions as to the mode of variation of the wind, etc., leads to a number of types of acoustic maps, having, for example, successive zones of silence, or, again, reinforcement along certain directions, not necessarily that of the wind and its opposite, or, in some cases, actual acoustic foci at certain points. With temperature rapidly decreasing on ascent from the ground, and with the vertical gradient of wind velocity very small, it may happen that the first zone of silence begins at the centre of the explosion itself. Thus, points in the neighbourhood of the source the sound reaches only by diffraction. G. A. S.

2303. *Theory of Hearing.* **G. Wilkinson.** (Nature, 113. pp. 781–782, May 31, 1924.)—E. W. Scripture repeats (*ibid.*, p. 605, April 26, 1924) the criticisms of the resonance theory of hearing put forward by him in the *Lancet* (November 4, 1922). The value and interest of Scripture's work on phonetics and the analysis of the speech curves of vowel sounds is acknowledged by the present author, who then concentrates on the deduction by Scripture that the perception of vowel sounds by the human ear is incompatible with the resonance view of the mechanism of the cochlea. Reference is next made to the plain experimental fact that the different vowel sounds are readily reproduced by such imperfect resonators as the strings of a piano, as mentioned in Ellis's translation of Helmholtz (p. 129).

Scripture's statement that sounds containing inharmonic partials are incapable of being completely resonated is objected to as a new doctrine that cannot be accepted without further proof.

The present author is also unable to acquiesce in any of Scripture's statements regarding the structure of the cochlea. These statements do not seem to be drawn from any of the recognised anatomical sources. Various details as to the cochlea are then entered upon and references made to the author's previous work. The article includes three reproductions of cross-sections of the cochlea. E. H. B.

2304. *Elastic Impact of Pianoforte Hammer.* **S. Bhargava** and **R. N. Ghosh.** (Phil. Mag. 47. pp. 1141–1148, June, 1924. Paper read before the Indian Science Congress, Jan., 1923.)—Helmholtz built up his classical theory of the vibrations of pianoforte strings on the assumption that the law of pressure was given by F sin *pt*. He regarded the hammer as elastic and the duration of impact as small compared with the period of vibration of the string. Later on (Ann. der Physik, 1895) Kaufmann showed that the duration of impact was comparable to the period of vibration of the string, and he based his theory on the assumption that the hammer was hard. Raman and Banerji conjointly, and Das separately, have recently extended the theory of the hard hammer and given a method for calculating the duration of impact in the general case when the striking-point is anywhere on the string. The present paper develops the theory of impact of the elastic hammer when the duration of impact is comparable to the period of vibration of the string. This theory has been tested by experiments with hammers and strings actually used in the piano. The theory is more general than Kaufmann's, and includes his as a special case. The paper gives five photographic reproductions of displacement-time curves of the hammer and string. Calculation of intensities of partials and comparison with experiments it is hoped to give later. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

2305. *Electromagnetic Equations of Dimensions.* **E. Brylinski.** (Comptes Rendus, 178. pp. 1519–1520, May 5, 1924.)—The fundamental equations being $\int \mathbf{h}\,dl = 4\pi i$ and induced e.m.f. $E = -\partial \mathbf{B}/\partial t$, the corresponding equations of dimensions are: $[\mathbf{h}] = [i \,.\, L^{-1}]$ and $[E] = [\mathbf{B}T^{-1}]$. But $[E] = [\phi \,.\, L]$, where ϕ is the induced electric force. Also, $[i] = [q/t]$ and $[q] = [\mathbf{I}] = [\mathbf{i} \,.\, L^2]$. Therefore $[\mathbf{h}] = [\mathbf{i} \,.\, L^2 \,.\, T^{-1}][L^{-1}]$ and $[\phi] = [\mathbf{B}'T^{-1}][L^{-1}] = [\mathbf{b}L^2T^{-1}][L^{-1}]$. Now give the L's their proper directions: Let the current, the electric field and the electric induction be along the axis of x and the magnetic field and induction be along that of y; then the equations of dimensions become $[\mathbf{h}] = [\mathbf{i}YZ \,.\, T^{-1}][Y^{-1}] = [\mathbf{i} \,.\, ZT^{-1}]$ and $[\phi] = [\mathbf{b}_1XZ \,.\, T^{-1}][X^{-1}] = [\mathbf{b} \,.\, ZT^{-1}]$. That is, $\mathbf{h}$ is related to $\mathbf{i}$ and ϕ to $\mathbf{b}$ by a velocity term ZT^{-1} at right angles both to $\mathbf{h}$ and to ϕ. Again, $(\mathbf{i}/\phi)(\mathbf{b}/\mathbf{h})$, $= K\mu$, $= (ZT^{-1})^{-2}$, which points to a velocity $= (K\mu)^{-\frac{1}{2}}$ at right angles to $\mathbf{h}$ and to ϕ. A. D.

2306. *Electric Currents in Moving Continuous Media.* **L. Roy.** (Comptes Rendus, 178. pp. 1693–1695, May 19, 1924.)—The electrodynamic theory applied to stationary media, as described in a previous paper [see Abstract 2122 (1922)], is extended to cover the case for media in motion. The treatment is mathematical. A. B. C. L.

2307. *Explosion of Electron in Quantum Theory.* **C. E. Guye.** (Arch. des Sciences, 6. pp. 4–6, March–April, Supplement, 1924. Paper read before the Soc. de Physique et d'Histoire Naturelle, Geneva.)—A charge e on the surface of a sphere (electron) of radius r_0 is in equilibrium under e.–s. forces of repulsion and an antagonistic Poincaré superficial pressure; its total potential energy is $\frac{2}{3}e^2/r_0$, whereof $\frac{1}{2}e^2/r_0$ is due to e.–s. forces and $\frac{1}{6}e^2/r_0$ to the opposed superficial pressure, Langevin [see Abstract 13 (1914)]. Its inertia is $m_0 = (\frac{2}{3}e^2/r_0)/c^2 = 0{\cdot}9 \times 10^{-27}$ grm. for the negative electron. Suppose a transition from one orbit to another, with liberation of energy; and that the equilibrium is broken, so that a charge e' escapes under repulsion. The energy will become $\frac{2}{3}(e - e')^2/r_0$ and the dispersed energy is $\frac{2}{3}\{e^2 - (e - e')^2\}/r_0 = \frac{2}{3}\{2ee' - e'^2\}/r_0 = h\nu$. When e' is small, we have $e' = \frac{3}{4}(h\nu)r_0/e$. For extreme ultra-violet ($\lambda = 10^{-5}$ cm.), $e' = 5{\cdot}7 \times 10^{-15}$, to compare with $e = 4{\cdot}77 \times 10^{-10}$; so that the dynamics of the electron are inappreciably affected. If, on the other hand, the explosion of the charge be complete and $e' = e$, we have $\lambda = 2{\cdot}4 \times 10^{-10}$, of the order of gamma-rays ($\lambda = 1{\cdot}4 \times 10^{-8}$ to 10^{-10}, Kaye). The complete explosion of a positive charge would give wave-lengths 1830 times smaller than this. We may therefore consider X-rays and gamma-rays as being due to more or less complete explosion of the charge of an electron. A. D.

2308. *Inertia of a Spherical Electric Layer Under Divergent Movement, and the Emission of Quanta.* **C. E. Guye.** (Arch. des Sciences, 6.

pp. 6–8, March–April, Supplement, 1924. Paper read before the Soc. de Physique et d'Histoire Naturelle, Geneva.)—This is a sequel to the preceding paper. A spherical electric layer under translation has a magnetic field; if dilating, it has none. Under dilation it has no inertia unless it contain some other energy (*e.g.* energy of vibration) within it. The e.-s. forces ought to give it an infinite velocity in the shortest time; but its e.-s. field vanishes as its radius is increased and energy is liberated. Assume that this energy takes the form of vibration within the dilating layer; then the rate of dilation could not exceed the velocity of light. The differential equation of motion is

$$f = m\beta\frac{\partial\beta}{\partial r} + \beta^2\frac{\partial m}{\partial r}$$

in which m at each r is the energy liberated by the e.-s. field. From this we have

$$\sqrt{1-\beta^2} = \frac{\epsilon_0 r_0 r}{r(1+\epsilon_0 r_0) - r_0}$$

where ϵ_0 is a small quantity proportional to the initial inertia. For $r = r_0$, $\beta = 0$; for $r = \infty$, $\beta < 1$; but if ϵ_0 approach zero, β approaches unity. Therefore as the initial inertia approaches zero the speed of dilatation approaches the velocity of light whatever be the charges; and the dilating sphere can carry with it a finite amount of energy, while under translation it could not.

This, with the preceding paper, suggests a mechanism for the emission of quanta. The small charge ϵ' lost by the electron dilates in the manner indicated and the small variation in the potential energy of the charge on the electron represents a quantum, reproduced as energy of vibration within the dilating charge. At the same time the charge dematerialises as the radius increases, in the sense that it would have no inertia for translatory movement apart from the vibratory energy contained within it. It remains to be seen how far this conception may agree with the electromagnetic wave and the phenomena of optics. A further communication on this subject is promised. A. D.

2309. *Electromagnetic Induction in a Homogeneous Solid Conducting Sphere Rotating about an Axis Perpendicular to a Uniform Alternating Magnetic Field.* **A. Marcus.** (Phys. Rev. 24. pp. 68–78, July, 1924.)—(1) *Mathematical Theory.*—The differential equations of the field are solved by a method first given by H. Lamb. The induced currents are found to flow in concentric shells; to an observer moving with the sphere they would be equivalent to two sets of steady currents revolving in the sphere with frequencies equal respectively to the sum and the difference of the frequencies of the impressed alternating field and of rotation of the sphere. The currents may be supposed to diffuse from the surface inward in the usual manner; at higher frequencies the penetration is smaller, resulting in a "skin effect" for high frequencies. Equations are also derived for the resulting magnetic field and for the torque on the sphere and for the logarithmic decrement in the case of an oscillating conducting sphere. (2) To test the theoretical results, *measurements of the logarithmic decrement of a solid metal ball* oscillating about a vertical axis in an alternating field produced by a long horizontal solenoid were made, and the results for three balls were found to agree with values computed from the theoretical expression for the torque within the limit of experimental error, which was not greater than a few tenths per cent. **Author.**

2310. *Contact P.D. Between Metals Glowing in vacuo.* **R. Vieweg.** (Ann. d. Physik, 74. 2. pp. 146–170, May, 1924.)—Method for estimating the contact p.d. apart from the current used for heating the metals *in vacuo*. A brief heating is sufficient to raise the potential of a metal appreciably. Continued heating produces a small further effect. It would appear that the phenomena of contact p.d. are due to the surface-film, but not entirely so. A. D.

2311. *Numbers of Ions in the Atmosphere.* **S. Wiedenhoff.** (Meteorolog. Zeits. 41. pp. 72–73, March, 1924.)—The number of ions per cub. cm. in the atmosphere near the earth is found to present a maximum (say 796 +, 769 −) in August and a minimum (596 +, 567 −) in February, with a secondary maximum (745, 760) in April and a secondary minimum (634, 601) in May; and generally the number is greater the hotter or the less cloudy the weather. The greater the number, the greater the liability to atmospheric disturbances in spark wireless. A. D.

2312. *Atmospheric Electricity Data.* **H. Markgraf.** (Meteorolog. Zeits. 41. pp. 65–71, March, 1924.)—A discussion of periodicities in these, observed at Potsdam during fifteen years. A. D.

DISCHARGE AND OSCILLATIONS.

2313. *Cathode-fall in Glow Discharge and Energy of Liberation of Electrons.* **A. Günther-Schulze.** (Zeits. f. Physik, 24. 1. pp. 52–55, 1924.)—Between the normal cathode-fall V_n on a metal and the liberation-energy ϕ of the electron there exists a simple relation $V_n = C\phi$, where C is a constant characteristic of each kind of gas employed. A. D.

2314. *Theory of Electron Emission.* **S. Dushman.** (Am. Electrochem. Soc., Trans. 44. pp. 101–116; Disc., 116, 1923.)—In this paper the Nernst heat theorem is applied to the evaporation of electrons. The theoretical treatment is analogous to that already developed for the evaporation of a monatomic substance. This leads to an equation for electron emission which assumes the form $I = A_0T^2\epsilon^{-b_0/T}$, where A_0 is an integration constant whose value may be calculated, and $b_0 = L_0/R$ in which L_0 denotes the heat of evaporation at the absolute zero. The significance of this equation is that it involves only one unknown constant, b_0, instead of two as in Richardson's equation. The physical significance of b_0 has been the subject of considerable speculation. It is shown that b_0 is relatively low for the very electro-positive elements, and its value increases with decrease in electro-positive characteristics. It also appears to be a periodic property of the elements, but more data must be obtained before any reliable conclusions can be drawn regarding the relation between the electron affinity and the other properties of the atom. Experimental data on the emission from various metals are found to be in satisfactory agreement with the new equation. The problem of efficiency of electron emission and the effect of field strength on emission is also discussed [see also Abstract 1878 (1924)]. A. E. G.

2315. *The Theory of Thermionics.* **H. A. Wilson.** (Phys. Rev. 24. pp. 38–48, July, 1924.)—*Thermodynamical Theory of Electron Emission from Metals.*—By means of a reversible cycle similar to that first used by O. W. Richardson an accurate expression for the thermionic emission is obtained, and it is shown that the constant in the equation for the vapour pressure of the electrons is equal to the chemical constant for electron gas. It is shown that if all the internal heat of evaporation of the electrons is due to electrical forces, then Richardson's original equation $I = A\theta^{1/2}\epsilon^{-b/\theta}$ must be correct, and the specific heat of the negative electricity in the metal must be the same as for a monatomic gas at constant volume, but that if this specific heat is small, as is known to be the case, then all the internal heat of evaporation cannot be due to electrical forces, and Richardson's second equation $I = A\theta^2\epsilon^{-b/\theta}$ is a better first approximation to the exact relation. It is shown that the equation $L = R\theta_2 d(\log p)/d\theta$, where L is the heat of evaporation of a liquid at pressure p, and temperature θ is not exactly true for the evaporation of electrons.

Quantum Theory of the Chemical Constant.—A simple way of calculating the size of the region element in the state space for a monatomic gas is given which makes it equal to Nh^3, where N is the number of molecules in the gas and h is Planck's constant. This gives the same expression for the chemical constant as that found by Sackur. AUTHOR.

2316. *Consumption of Energy when Air is Ionised by X-rays of Different Wave-lengths.* **L. Grebe.** (Zeits. f. Physik, 24. 3–4. pp. 264–266, 1924.)—The result of Boos [see Abstract 2097 (1922)] that X-rays of shorter wave-length consume a greater amount of energy in ionising air than those of greater wave-length is explained by the fact that, with the short-waved X-rays besides the relatively quick photoelectrons, slow Compton electrons are also generated. These consume a relatively large amount of energy, while their ionising action is only small. An exact knowledge of the dependence of ionisation on the wave-length may perhaps also give a means of ascertaining the distribution of energy exchanges in the two processes—photo-effect and Compton-effect. A. E. G.

2317. *Studies with Ionisation Gauge. Part II. Relation Between Ionisation Current at Constant Pressure and Number of Electrons per Molecule.* **C. G. Found** and **S. Dushman.** (Phys. Rev. 23. pp. 734–743, June, 1924.)—*Calibration Constants for the Ionisation Gauge in Various Gases.*—The relation for the pressure P = K × positive ionisation, where K is a constant, was found to hold for Hg vapour (0·025 to 0·21 bar) and for iodine vapour, assuming published values of vapour pressures. For H_2, He, Ne, N_2 and CO at pressures around 50 bars, readings were compared with those of a McLeod gauge and the values of K determined. For the same electrical conditions (anode voltage and electron current) 1/K is found to be proportional to the total number of electrons per molecule or molar number N (except for H_2 and He, for which KN is half as large). Measuring i_+ in microamps, and P in bars, the value of the constant KN is 10·4 for an electron current at 0·5 microamp. and an accelerating voltage of 125 volts. Results for the vapour pressure of water and of HgI_2 also agree with this relation.

Relative Ionisation Due to Slow Electrons in Various Gases is, then, proportional to the pressure and to the molar number (except for H_2 and He). This agrees with results previously obtained for ionisation by α- and β-rays, except that for these H_2 is not abnormal. From the electron current K and the mean free path the fraction of the collisions with molecules which produce positive ions can be computed. It comes out ¼ in argon for an accelerating potential of 125 volts.

Vapour pressures of napthalene, − 11° to 18° C., and ot *vacuum oil* 0° and 25° C., were determined, assuming probable values of K [see Abstract 578 (1921)]. AUTHORS.

2318. *The Constitution of Gaseous Ions and Mobilities in Dry and Moist Air.* **J. J. Nolan.** (Phys. Rev. 24. pp. 16–30, July, 1924.)—Using the Franck modification of the Rutherford alternating-current method, with the plate and gauze accurately parallel and 2·5 cm. apart, current-voltage curves were obtained as the 52-cycle voltage was increased from 200 to 500 volts. Previous experiments have shown the presence of four predominating types of positive ions with mobilities of 2·04, 1·73, 1·52 and 1·34. The curves now reproduced show periodic inflections about every 10 volts, which indicate intervening groups making some twenty groups of ions with mobilities varying from 2·24 to 1·34. These values agree closely with those computed according to J. J. Thomson's theory for clusters of from 15 to 36 water-molecules. In dry air the groups with the lower mobilities are less prominent. Other experimental evidence is cited in favour of the cluster theory as opposed to the small ion theory of ions. Loeb's criticism of the author's work is discussed, and it is shown that there is no real divergence between these results and those of Loeb. AUTHOR.

2319. *The Influence of the Shape of the Kathode on the Normal Current Density of the Glow Discharge.* **A. Günther-Schulze.** (Am. Electrochem. Soc., Trans. 44. pp. 215–224; Disc., 225–226, 1923.)—To determine the effect of the shape of the kathode on the normal current-density one of two similar iron strips (*k*) was bent to a **U** form, and the other (1) was used flat. Current was sent in either direction between them, when surrounded with hydrogen at a number of different pressures; in each case the current was measured when the strips were just surrounded by the glow discharge. At very low pressures the current i_k with (*k*) as kathode was about half that with (1) as kathode ($i_k/i_1 = 0{\cdot}517$); but at a critical pressure, about 2·25 mm., i_k rises rapidly as compared with i_1, and at 2·27 mm. i_k/i_1 is 5·98; for still higher pressures the ratio falls off again rapidly, and at 7·88 mm. pressure is 0·579. At the critical pressure the strip and the slit-like space between the arms of the **U** are so strongly heated that the gas density decreases, until the dark space no longer exists in the slit; the glow discharge disappears, the current falls from 80 to 13 milliamperes, the sheet cools down until the discharge can again jump into the slit, and so on. By this means the kathode can be heated very strongly. When the two arms are so close that the electrons from the inner surface of one penetrate into the dark space in front of the other inner surface, they move against the field in the last part of their path, and they may be brought to rest and pass back into the glow. The kations produced in the dark space persist, since the field strength in the dark space is high and little recombination takes place. More kations are available on both sides than before. These produce more electrons, and so the two arms working together increase each other's current densities. In the *Discussion*, **C. G. Smith** mentioned experiments made by **V. Bush** and himself, in which a magnetic field parallel to the common axis of concentric cylindrical electrodes decreased the dark space of the glow discharge between them. The field increases the probability for the production of kations near the kathode. The recombination phenomenon was under these conditions a negligible factor. He considers the distribution of positive space charge a more powerful factor in determining the current than the recombination phenomena. H. N. A.

2320. *The Electrodeless Discharge.* **G. Mierdel.** (Phys. Zeits. 25. pp. 240–255, May 15, 1924.)—A *résumé* of the work on this subject dealt with under the following heads: 1. The discharge, using outside electrodes; (*a*) electrical properties, (*b*) optical properties, both of which sections are illustrated with diagrams. 2. The electrodeless ring-current; (*a*) the fundamental phenomena, (*b*) electrical measurements, (*c*) nature of the ring discharge, (*d*) optics of the ring discharge, (*e*) outside magnetic fields, (*f*) mechanical actions. A list of the most important papers on the subject is appended. A. E. G.

2321. *The Measurement of Critical Voltages.* **Lydia Inge** and **A. Walther.** (Zeits. f. Physik, 24. 5–6. pp. 400–401, 1924.)—The authors investigate the influence of the mesh of the wire gauze employed in measurements of ionisation voltage; this was varied from 0·2 mm. wire diameter and 0·8 mm. spacing to 0·5 mm. diameter and 2 mm. spacing. The methods of Franck and of Goucher were employed, with mercury and cadmium, and no difference was found between the values of the ionisation voltage due to change in the wire gauze employed. H. N. A.

2322. *Currents Limited by Space Charge between Concentric Spheres.* **I. Langmuir** and **Katharine B. Blodgett.** (Phys. Rev. 24. pp. 49–59, July, 1924.)—*Concentric Spheres.*—Calculation of the function $\alpha = f(r/r_0)$ in the space charge equation $i = (4\sqrt{2}/9)\sqrt{(e/m)}\,V^{3/2}/\alpha^2$.—The coefficients of the first six terms of a series for α were determined, and α^2 calculated from this series. The results were checked by an integration method, which was also used to calculate values in the region where the series failed. For an emitter of radius r_0 inside a collector of radius r, values of α^2 when $\log (r/r_0) > 6{\cdot}4$ are given by the equation

$$\tfrac{1}{2}\alpha^2 = 0{\cdot}112 \log (\log r/r_0) + \tfrac{1}{3} \log (r/r_0) + 0{\cdot}152.$$

Where the collector is the inside sphere, values of α^2 for $r_0/r > 9$ are given by the equation $(\tfrac{1}{2}\alpha^2)^{2/3} = 1{\cdot}11\,(r_0/r) - 1{\cdot}64$. It is shown that when the collector is the inside sphere the potential distribution near the collector is unaltered if the emitter is replaced by a non-emitting sphere with a diameter 0·677 times the original diameter.

Limiting Current Between Coaxial Cylinders and Between Concentric Spheres.—Equations are derived for the current in terms of the radius of curvature of the emitter. It is shown that at a surface in space four-fifths of the distance from the emitter to the collector the current density is independent of the radius of curvature when r/r_0 or $r_0/r < 2$; and in the case of coaxial cylinders with the emitter inside this holds true even when $r/r_0 = 20$. AUTHOR.

2323. *Surface Complications in the Corona Discharge.* **F. O. Anderegg.** (Am. Electrochem. Soc., Trans. 44. pp. 203–214; Disc., 214, 1923.)—A careful study of the literature covering ozone formation and other chemical reactions in the corona discharge bring to light certain unexplained deviations in the results, which are much greater than the variations in the supply of electrical energy or in other conditions might be expected to produce. It is the purpose of this paper to present evidence, obtained in working with different types of discharge, that the variations noted are due, to a greater or less extent, to disturbing effects at the walls of the apparatus. The results indicate a complicated series of chemical reactions in the corona discharge, together with adsorption of some at least of the products on the surfaces. The following hypothesis will explain most of the results obtained: At first ozone is formed and then nitrogen peroxide accumulates gradually. Heavy ions of low mobility which decrease the conductivity are formed, explaining the first drop in wattage and power-factor curves. These heavy ions or molecules condense out on the walls with more or less lag to produce kinks in the curves given. These adsorbed substances, containing probably heavy oxides of nitrogen which are quite polar, have a high dielectric constant, causing an increase in discharge density, explaining the rise in power-factor and wattage curves. Oxides then decompose the ozone, so that when it decreases below a certain value it is less than the desorption, and the pressure rises. Some of the heavy molecules evaporate, slowing up the speed of the ions and decreasing the conductivity, explaining the sharp drop in the power-factor and other curves. With the decomposition of the heavy ions there is another kink, from which the conductivity and pressure rise to a steady state which was reached at 8400 volts in about 30 minutes after reversal. Increases in temperature in the intensity of the discharge or in the amounts of nitrogen oxides, contaminants from previous runs, will lower the ozone concentration and so speed up the reversal. Variations in results follow variation in the extent and in the degrees of saturation and of activation of the surface. From the experiments it may be concluded that the choice of material of which to make a discharge tube for the quantitative study of chemical reactions in the corona discharge is very important. The use of a dielectric such as glass to intensify the discharge is apt to cause complications, not only because of adsorption that may occur, but because of the probable existence of progressive changes within the dielectric under stress. A. E. G.

2324. *The Electrochemistry of the High-Intensity Arc.* **P. R. Bassett.** (Am. Electrochem. Soc., Trans. 43. pp. 153–172; Disc., 172–174, 1923.)—The high-intensity arc is a distinct type of electric arc which has been developed during the past ten years. A. Blondel was the first to note and record the positive flame effect at high currents in mineralised carbons, but did not follow up the matter. Beck some time later attempted to produce this type of arc by surrounding the burning electrodes with an inert gas, such as alcohol vapour, but his method has been proved impracticable and is now obsolete. To E. A. Sperry the credit is due for the successful development of the high-intensity arc in its present commercial form. The fact that it has been found impracticable to operate this arc at less than 50 amps. or in units of less than 20,000 c.p. has confined its utilization to special fields. It is the most ideal source for searchlights yet discovered, since its outstanding properties are tremendous brilliancy and extreme concentration approaching the point source. The present paper is claimed to be the first attempt at a complete explanation of the phenomena involved. In the experiments described the horizontal arc is employed, and diagrams are given showing a series of arcs between ordinary carbon electrodes for currents of 20, 40, 80, 150 and 300 amps. In producing the flame arcs, the positive electrode used consists of a core of cerium fluoride and carbon, and the shell consists of a non-graphitisable pure carbon, such as produced from a lamp-black base. Carbon arcs and ordinary flame arcs change their behaviour fundamentally with large currents. The tendency to produce two arc flames, a positive and a negative, is present in an obscure form in practically all arcs. In the high-intensity arc this phenomenon has been enhanced to a point where the two flames are separate and distinct, and each flame performs a separate function. The high intrinsic brilliancies obtainable with this type of arc are discussed, and the carbide flame has been suggested as an explanation for the abnormal brilliancies produced. A. E. G.

2325. *A New Source of Very Short Electromagnetic Waves.* **A. Glagolewa-Arkadiewa.** (Zeits. f. Physik, 24. 3–4. pp. 153–165, 1924.)—Fine metallic filings (brass or aluminium) are kept in fairly uniform suspension in machine-oil by means of a stirrer. Half-dipping in the liquid is a rotating wheel which is constantly carrying a mixture of oil and filings on its periphery, the rotation ensuring regular renewal. The terminals of an induction coil are placed near the edge of the wheel so that the spark passes through the surface layer of oil and filings. Waves are given off from the filings, the frequency being governed mainly by the dimensions of the filings. The energy and wave-lengths have been investigated by an interferometer method. The source is at the focus of a parabolic mirror, the waves being reflected to two plane mirrors, one of which is movable. They are further reflected to another parabolic mirror, at the focus of which is a thermo-element. In the usual way, by observing the galvanometer deflection and its relation to the movement of one of the mirrors, the wave-lengths and relative energies of the components of the beam may be found. For example, in one case the wave-lengths varied from 40 mm. to 3·6 mm., most of the energy being in the long waves. By shielding, the distribution of the energy between the different waves may be varied. Figures are given showing the relative transmitting powers of substances such as wood, paper, glass, etc. The shortest wave-length observed is about 0·082 mm. A. A. D.

2326. *A Method of Producing a Square Wave of Radio-Frequency.* **J. L. Bowman.** (Phys. Rev. 24. pp. 31–37, July, 1924.)—A radio-frequency square wave, *suitable for the measurement of the mobility of ions*, has been obtained by using a circuit containing three vacuum tubes. The first tube operates as an oscillator. The potential of the second tube, which operates as a rectifier, is controlled by the grid circuit coil of the oscillator. The third tube is connected so that the plate current will be cut off during the half-period when the rectified current is flowing in the plate circuit of tube 2. The rise of the voltage of the square wave is approximately exponential, due to the charge on the grid and the plate of tubes 2 and 3, which must be discharged through a resistance which couples the plate circuit of tube 2 to the grid of tube 3. A kathode-ray oscillograph tube indicates that the voltage rises to approximately its maximum value in 1/10 of the half-period. A square wave of 120 volts may be obtained with Western Electric "E" tubes. Three methods of amplification are given by which a square wave with a very much larger voltage may be obtained.

AUTHOR.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2327. *Dielectric Constants and Chemical Constitution with Organic Liquids.* **E. H. L. Meyer.** (Zeits. f. Physik, 24. 2. pp. 148–152, 1924.)—Walden's attempt to explain the varying magnitudes of the absolute dielectric constants of organic liquids on the basis of their chemical constitution (Zeits. phys. Chem. 70. p. 569, 1910) is not entirely satisfactory. A more complete explanation is furnished if polar carbon atoms are regarded as embracing: (1) Carbon atoms with at least two valencies saturated by two different atoms besides carbon; (2) carbon atoms linked with a uni- or poly-valent electronegative inorganic substituent, the other valencies being united only with carbon. All organic liquids with such polar carbon atoms are dipolar liquids [Abstract 571 (1912)]. Liquids with one polar carbon atom in the molecule exhibit comparatively high absolute values of the dielectric constants, which vary considerably with the temperature. When two or more polar carbon atoms are present in the molecule, the absolute value of the constant and its variation with the temperature represent the mean result of several separate actions.

T. H. P.

2328. *Piezo-electricity and Molecular Asymmetry.* **R. Lucas.** (Comptes Rendus, 178. pp. 1890–1892, June 2, 1924.)—J. and P. Curie have stated that for a crystal to show piezo-electric properties it must belong to a class without a centre of symmetry. Such crystals are those possessing inclined hemihedral faces. On the other hand, optically active crystals have neither a plane nor a centre of symmetry. It results that all optically-active bodies should give crystals with piezo-electric properties. This fact has been verified for a large number of crystals, and no exceptions have been found. The piezo-electric method thus furnishes a convenient means for deciding problems in crystalline symmetry.

A. A. D.

2329. *Behaviour of India-rubber as a Dielectric.* **J. Villey, P. Vernotte and H. Lacaze.** (Comptes Rendus, 178. pp. 1612–1614, May 12, 1924.)—If a constant potential difference be maintained between the plates of a condenser whose interspace is filled with india-rubber, and the current plotted against the time, it is found that the curve obtained fits very closely a rectangular hyperbola, the axes of current and time being parallel to the asymptotes. When $t = 0$ this gives the current a finite value not capable of direct measurement. When $t = \infty$ a positive value is obtained characterising the true ohmic resistance. A construction is indicated by which the asymptotes can be obtained from the experimental curve. The characteristic constants of the curve vary rapidly with temperature.

G. A. S.

2330. *Electric Conductivity of Flames Containing Alkaline Salts.* **A. Pontremoli.** (Accad. Lincei, Atti, 33. i. pp. 223–227, March 16, 1924.)

—Mathematical treatment of the hypothesis (H. A. Wilson) that in a flame containing an alkaline salt there is thermic equilibrium of ionisation between this salt and a product of combustion pertaining to the flame. It is possible theoretically to determine the effective value of the electric conductivity, in a region where Ohm's law applies, in terms of the temperature of the flame and of universal and atomic constants. A. D.

2331. *Electric Conductivity in Binary Metallic Alloys.* **M. Pirani** and **J. Runge.** (Zeits. f. Metallkunde, 16. pp. 183–185, May, 1924.)—The conductivity can be computed for a case in which the one component is enclosed within the other in the form of cylinders or of spheres (Rayleigh, Stepanow). The formulæ are applied to particular experimental cases. Similarly, the influence of a superficial separation of one of the components can be investigated. This points the way to a theoretical prediction of the conductivity of a binary alloy. A. D.

2332. *Metallic Conductivity.* **E. Kretschmann.** (Ann. d. Physik, 74. 3. pp. 189–215, May, 1924.)—Debye showed in 1911 that we could not neglect the mutual action of the conduction electrons (Coulomb's law) in comparison with the action of the atoms upon these; but he arrived at an expression for the metallic conductivity containing $\{\nu e^2/(\mu\pi a^2 + 4\nu\pi a_1^2)\}$ as a factor, where μ is the number of atoms and ν the number of free electrons per unit volume, a is the sum of the radii of an atom and an electron, and a_1 is the radius of an electron; and this expression has a finite value when $\mu = 0$, whereas it should in that case be infinite. The author envisages a crowd of free electrons, such that the influence of other electrons may be neglected in comparison with that of the atoms. The movements are irregular, and the evaluations are statistical. The spontaneous decay measures the resistance. On these lines general expressions are arrived at for electrical conductivity under any unspecified velocity-distribution of the electrons; velocity-distribution is deduced from the radiation laws for $\lambda = \infty$; the velocity-distribution laws are deduced for single molecules; an example is worked out; and harmony is shown to exist between the general expressions arrived at and the radiation and velocity-distribution laws, from which, conversely, the general expressions may be deduced. A. D.

2333. *Electrical Resistance of Aggregates.* **K. Lichtenecker.** (Phys. Zeits. 25. pp. 169–181, April 15., 193–204, May 1, and pp. 225–233, May 15, 1924.)—The author treats of a rigorous analytical method of setting comparatively close limits to the resistivity of an artificial two-dimensional aggregate, in terms of the resistivities of its constituents. The previous method of assuming either an arithmetic mean resistance or an arithmetic mean conductivity gave limits many times more widely separated.

It is shown that there are two pairs of such limiting values in every case, according as the better or worse conductor is regarded as the "inserted" substance. General expressions are worked out for these limits, assuming (*a*) different shapes of inserted particles (square, circular and elliptical), (*b*) various orientations of these with reference to the direction of the current, (*c*) different lattice arrangements. These are evaluated numerically for selected cases. The surprising result is found that these narrow limits, and therefore also the true value included by them, depend hardly at all on the shape, orientation and arrangement of the particles. The means of the four limits agree with one another to 1 part in 1000 in every one of the six cases investigated. For circular enclosures the values of the four limits are calculated as a function of the relative volumes occupied by the constituents for various ratios of their resistivities. They are given in tabular form, and also graphically to enable comparison to be made with previous limits deduced by Guertler. The recent measurements of W. Esmarch, using the method due to Benedicks, are shown to yield values in excess of those theoretically possible, although the discrepancies here are less than in the original measurements of Benedicks.

A general expression is found for the resistivity of a two-dimensional aggregate with given volume ratios and resistivity ratios for the constituents. This expression satisfies the demand that resistance and conductivity should be capable of being worked out similarly and with the same degree of reliability. The expression in question is $\sigma = \sigma_1^{\theta}\sigma_2^{1-\theta}$, where σ is the resistivity of the aggregate, σ_1 and σ_2 the resistivities of the constituents, and θ is the fraction of the volume occupied by the constituent 1. The values given by this expression are not only never in contradiction with the results of the exact analysis, but dovetail excellently into them in that for various values of the ratio σ_1/σ_2, and through the whole range from $\theta = 0$ to $\theta = 1$, they lie accurately in the middle of the very narrow interval of overlap of the ranges for "better conductor inserted" and "worse conductor inserted." The above formula can also be written $\log \sigma = \theta \log \sigma_1 + (1 - \theta) \log \sigma_2$, and may be expressed by saying that the logarithm of the resistivity of the aggregate is found by mixing in proportion to the respective volumes occupied by them the logarithms of the constituents.

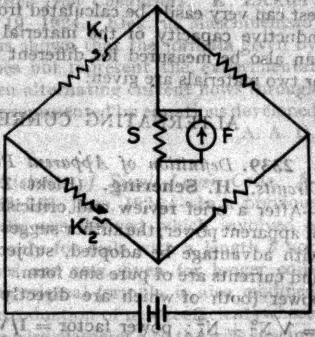
The analytical and numerical working out of the four limiting values is also done for the case of a three-dimensional, *i.e.* a solid aggregate, and the general formula is adapted to this case also. The values found from these considerations agree within the limits of experimental error with the results of Matthiessen's experiments on five different alloys free from compound crystals. The present results also agree to 1 part in 500 with the values for similar aggregates worked out by the author in 1909 by quite a different method. G. A. S.

2334. *Conductivity of Electrolytes under High Frequencies.* **J. Granier.** (Comptes Rendus, 178. pp. 1520–1522, May 5, 1924.)—On eliminating causes of error, it was found that there was no appreciable change in the conductivity at high frequencies; the electrolytic resistance appears even under exceedingly small displacements of the ions. A. D.

2335. *A New Type of Electrometer.* **B. Szilard.** (Comptes Rendus, 178. pp. 1887–1890, June 2, 1924.)—The paper describes the construction and operation of a new type of electrometer of robust construction and high sensitivity. The instrument is of the pointer type, thus requiring no optical arrangements, and does not need a high-voltage battery. Briefly, the essential parts consist of (1) a light needle suspended by a bronze strip so that it can move over a uniformly divided scale; (2) two pairs of fixed sectors, one above the other, between which the needle can oscillate. The sectors are joined electrically, and are mounted on an insulating support; they are charged by induction from a small frictional machine, a small cylindrical condenser serving to regulate the voltage to which the sectors are charged.

The instrument can be used for the same purposes as the quadrant electrometer, but is much less troublesome in use. It is portable, and requires none of the usual laboratory auxiliaries. The capacity of the electrometer is 9 e.s.u. when used heterostatically, and varies between 9 and 16 e.s.u. when used as an electrostatic voltmeter, being capable of adjustment by means of the variable condenser. The needle is about 100 mm. long, and the scale of 300 divisions covers 150 mm.; the voltage sensitivity is about 1 volt per division, with the sectors charged at 200 volts. Currents of the order of 10^{-12} amps. can also be measured. The period is about one second. A sectional plan of the electrometer is given, and a number of practical applications are suggested. B. H.

2336. *Theoretical and Experimental Study of the Fluxmeter.* **G. Darmois** and **G. Ribaud.** (Ann. de Physique, 1. Ser. 10. pp. 173–212, March–April, 1924.)—This paper is a full theoretical treatment of the modern form of Grassot fluxmeter, in which the moving coil is supported on pivots instead of being suspended by a cocoon silk fibre. In addition to the ordinary use of the instrument as a fluxmeter, its use for the measurement of time intervals is dealt with. In this a shunt S to the fluxmeter F forms the diagonal of a balanced Wheatstone bridge. If K_1 is broken the needle begins to move, and its motion ceases when K_2 is also broken. The angle turned through by the needle is according to the approximate theory proportional to the interval of time elapsing between the breaking of K_1 and K_2. For a p.d. of the order 1 volt at the shunt terminals the needle traverses the whole scale in 0·01 sec., and the time of traverse varies inversely as the applied p.d. The effect of air resistance, pivot friction, lack of balance on the indications of the instrument are investigated theoretically, and experimental methods described for determining the magnitude of the couples due to these several effects in any instrument. The performance of three fluxmeters with different values for these couples are compared with theory and the relative errors discussed.



The effect of the magnitude of the non-inductive resistance and the inclusion of self-inductance in the circuit of the fluxmeter coil are also treated. L. L.

2337. *Electrostatic Oscillograph.* **E. Pugno-Vanoni.** (Elettrotecnica, 11. pp. 388–390, June 15, 1924.)—The instrument consists of two phosphor bronze strips carrying a small mirror, as in the Duddell oscillograph. The strips are connected together and arranged between two pairs of deflecting plates so connected that the strips are deflected in opposite directions. The tension of the strips can be adjusted, and the whole instrument is immersed in oil. There are two ways in which the instrument can be used, either with the strips connected to one pair of the plates, giving a quadratic scale, or with the strips raised to a constant high potential by an independent battery, which gives a linear scale. The instrument is primarily designed for recording the form of the voltage curve of the supply to Röntgen-ray tubes. In general, it is then necessary to reduce the applied voltages by suitably arranged liquid resistances. For certain alternating current applications condensers can also be used for reducing the potentials actually applied to the instrument. A. Wh.

2338. *The Determination of the Specific Inductive Capacities of Ceramic Materials.* **A. Burmester.** (Archiv f. Elektrot. 13. pp. 146–152, March 31, 1924. From the Reichsanstalt.)—The material under test is made in the form of a cylinder with a hemispherical end, the other end being open. The outside is coated with copper foil nearly to the top, then there is a gap, and finally more copper foil. This latter serves as a guard ring. The inner coating is provided by filling the vessel with water. The capacity of this condenser is compared by a bridge method with that of a standard air-condenser. The capacity of an air-condenser similar to the one under test can very easily be calculated from the dimensions, and so the specific inductive capacity of the material can be found. The hysteresis loss can also be measured for different frequencies. Typical results for one or two materials are given. A. A. D.

ALTERNATING CURRENTS AND MAGNETISM.

2339. *Definition of Apparent Power and Power-Factor in Polyphase Circuits.* **H. Schering.** (Elekt. Zeits. 45. pp. 710–712, July 3, 1924.) —After a brief review and criticism of the various proposed definition of apparent power, the author suggests that the following definitions might with advantage be adopted, subject to the proviso that both voltages and currents are of pure sine form. Let N = true power; N_b = wattless power (both of which are directly measurable); then apparent power $= \sqrt{N^2 + N_b^2}$; power factor $= 1/\sqrt{1 + (N_b/N)^2}$, and "wattless factor" $= 1/\sqrt{1 + (N/N_b)^2}$. If the *current* wave only is distorted—but not excessively—the above definitions practically hold good, since the higher harmonics of the current wave do not contribute towards the true power, and only slightly affect the r.m.s. value of the current. If the *voltage* wave is distorted, but the current proportional to the voltage, the above definitions must be applied separately to each simple harmonic component; the sum of the component powers gives the total true power, and the sum of the wattless powers the total wattless power. Lastly, if the voltage wave is distorted and the current is not proportional to the voltage, the definitions must be regarded as only more or less rough approximations, and must be used with caution. A. H.

2340. *New Theory of General Alternating-Current Circuit.* **S. Fryze.** (Elekt. Zeits. 45. pp. 677–681, June 26, 1924.)—A highly condensed account of a new method of attacking the problem of the general alternating-current circuit, which aims at a higher degree of generality than has hitherto been attained. If W denotes any vector quantity (voltage, current, etc.) in such a circuit, it may be exhibited in the form $W = C_w/N$, and it may be shown that: (*a*) N is a function of the various impedances composing the circuit which has the same value for all vectors W, and in which the various impedances occur in the first power only; (*b*) C_w is a function of the impedances and e.m.f.'s in which both occur in the first power only; (*c*) the e.m.f.'s occurring in C_w never form products with each other. For a circuit containing k variable impedances and p variable e.m.f.'s we may therefore write $W = F_w(Z_x, Z_y, \ldots Z_k; E_u, E_v, \ldots E_p)/f(Z_x, Z_y \ldots Z_k)$, and this relation is termed the first fundamental equation of the circuit by the author. It may also be shown that for such a circuit of $k + p$ variables any vector W may be expressed in terms of the other vectors W_1, $W_2 \ldots W_{k+p}$ in the form $W = C_w + A_1W_1 + A_2W_2 + \ldots + A_{k+p}W_{k+p}$, where C_w, A_1, $A_2 \ldots$ are constants. This relation is termed the second fundamental equation by the author. The use of these equations is exemplified. The author draws attention to the fact that in the case of circuits containing more than one variable it is impossible to determine the constants by means of the no-load and short-circuit tests only (contrary to la Cour's assumption). A. H.

2341. *Alternating Current in Massive Iron Conductors.* **K. Zickler.** (Elekt. Zeits. 45. pp. 650–651, June 19, 1924. Elek. u. Maschinenbau, 42. pp. 391–393, June 22, 1924.)—It is shown that the formula given by Rosenberg [Abstract 299B (1924)] does not represent the experimental facts relating to the loss of energy when alternating current flows through iron conductors. The results are better represented by equations developed by the writer. A. A. D.

2342. *The Alternating-Current Resistance of Single-Layer Coils.* **S. Butterworth.** (Phys. Rev. 23. pp. 752–755, June, 1924.)—In a previous paper [Abstract 205 (1922)] a formula was derived which involved a function u_n whose values were given only for coils with a length b not greater than the diameter $2a$. Values are now given for longer coils with values of $b/2a$ from 1 to ∞. The original formula is also modified to include closely wound coils by the introduction of new coefficients whose values are given for various ratios of the wire diameter d to the wire spacing D. Comparison of computed values with measurements made by Hickman for coils with $b/2a$ between 3 and 12, shows for the original formula a maximum discrepancy of + 30 per cent. (instead of 300 per cent. as given by Hickman), and for the modified formula an average difference of only + 7 per cent. (calc. − obs.). AUTHOR.

2343. *Campbell's Driving-point Impedance Theorem.* **R. M. Foster.** (Bell System Techn. J. 3. pp. 259–267, April, 1924.)—The driving-point impedance of a network is defined as the ration of an impressed e.m.f. at a point in a branch of the network to the resulting current at the same point.

Campbell's theorem was stated by him (*ibid.*, Nov., 1922) without limiting it, as should have been done, to cases in which there is no dispersion. He gave no proof, and the present author has supplied one based upon the solution of the analogous dynamical problem of the small oscillations of a system about a position of equilibrium, in the absence of friction. The theorem is as follows: The most general driving-point impedance obtainable by means of a finite resistanceless network is a pure reactance which is an odd rational function of the frequency $p/2\pi$, and which is completely determined, except for a constant factor, by assigning the resonant and anti-resonant frequencies, subject to the condition that they alternate and include both zero and infinity. Such an impedance is physically realisable, provided the resistances can be made negligibly small, by a network consisting of a number of simple resonant circuits (with inductance and capacity in series) in parallel, or a number of simple anti-resonant circuits (with inductance and capacity in parallel) in series. The variation of the reactance with frequency is shown by curves for several simple circuits. G. W. DE T.

2344. *The Auto-Transformer and Impedance as a Tensor.* **W. H. Ingram.** (Phil. Mag. 47. pp. 1092–1095, June, 1924.)—In a recently published note [Abstract 507 (1924)] the author has given a formula for the step-down auto-transformer which showed that the secondary terminal voltage will be independent of the exciting current when a certain ratio exists between the self-impedances of the two windings into which the auto-transformer is divided by the tap. It is here shown that a similar phenomenon may be exhibited in the case of a transformer having a tapped primary, or, what is the same thing, a step-down auto-transformer having a metallically independent tertiary.

The author points out that impedances are tensors, and when defined as such enable the "symbolic" method to be established upon a purely vector basis. The tensor components of Z may be obtained from the work theorem for the most general simple circuit having lumped constants. G. W. DE T.

2345. *Jumping Phenomena in Ferro-resonance.* **Y. Watanabe.** (Inst. El. Eng. of Japan, J. No. 427. pp. 197–198, Feb., 1924.)

2346. *Potential Energy in Magnetic Circuit containing Imperfectly Polarisable Material.* **L. Lombardi.** (Accad. Lincei, Atti, 33. i. pp. 117–121, Feb. 17, 1924.)—Commentary on Perrin's results [Abstract 996 (1924)] and extension by taking into account the work necessary to bring the magnetic material from a neutral state to the final state and the amount of this which is stored up as potential energy. This may give rise to considerable heating. A so-called permanent magnet is not permanent unless the magnetic conditions remain unchanged, as in the absence of disturbing fields, internal or external. A. D.

2347. *The Magnetostriction of a Magnetite Crystal.* **C. W. Heaps.** (Phys. Rev. 24. pp. 60–67, July, 1924.)—Magnetostriction of an octagonal magnetite crystal along three axes was measured in fields up to 5000 gauss. The curves obtained are all similar in form, first convex towards the H axis, then concave, tending towards a maximum near 5000 gauss. With a longitudinal field of 5000 gauss, the digonal axis expands $30(10)^{-4}$ per cent., the trigonal axis $12(10)^{-4}$ per cent., and the tetragonal axis contracts about $4(10)^{-4}$ per cent. With an equal transverse field the percentage changes are a contraction of $44(10)^{-4}$, a contraction of $28(10)^{-4}$, and an expansion of $4(10)^{-4}$, respectively. Tests indicated that the effect perpendicular to a plane is independent of the direction of the field in that plane. No departure from cubic symmetry was established. To explain these results a model of the magnetic element in magnetite is suggested, similar to Ewing's recent model. The experiments favour the view that the rotating magnetic element is a group of non-parallel electron orbits inside the atom.

Permeability of a magnetite crystal was roughly determined to vary from 1·2 to 1·38 as the field strength increased to 5000 gauss. AUTHOR.

2348. *Furnace Permeameter for Alternating-Current Measurements at Small Magnetising Forces.* **G. A. Kelsall.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 669–674, May, 1924.)—The furnace permeameter described consists essentially of a permeameter of a type forming the subject of a previous paper [see Abstract 1583 (1924)], with the addition of an annular electric furnace immediately surrounding the sample under test and suitably heat-insulated from the other parts of the instrument. The permeability of ring samples for small magnetising forces at telephonic frequencies can be measured without the necessity of winding magnetising coils upon them. The range of working temperature available is from − 190° C. to 1000° C. By making the transformer core of high permeability material and of a mass many times larger than that of the sample to be tested, the magnetising force at which the sample is tested can be kept very nearly constant when a constant current is sent through the primary, notwithstanding the large variations in the permeability of the sample which frequently occur with temperature changes. A. B. C. L.

2349. *Hysteresis Loss in Asymmetrical Cycles.* **M. Paris.** (Elettrotecnica, 11. pp. 370–376, June 5, 1924.)—The asymmetry of any cycle is defined by the expression $\chi = (B_1 + B_2)/2B_1$, where B_1 and B_2 are the values of the induction at the ends of the cycle, near and remote from the origin respectively. The object of the research is to discover the relation between the degree of asymmetry, χ, and the hysteresis loss. It has previously been shown that the loss for asymmetrical is higher than that for symmetrical cycles. It is now discovered that for very slight asymmetry the loss is reduced, the effect being small. For the measurement both ballistic and watt-meter methods are used. A. Wh.

2350. *Law of Magnetic Pull.* **T. Lehmann.** (Rev. Gén. d'Él. 16. pp. 51–58, July 12, and pp. 99–103, July 19, 1924.)—A mathematical paper in which the author vindicates the formula previously deduced by him against the criticism of A. Liénard [see Abstract 308B (1924)], and solves the problem of finding the pull on a tooth or salient pole for the case in which the permeability is a function of H. **Errata,** *ibid.*, p. 368, Aug. 30, 1924. A. H.

2351. *Historical Notes on (a) The Compass, (b) The Holding Capacity of a Vessel at Different Distances from the Centre of the Earth.* **E. Wiedemann.** (Zeits. f. Physik, 24. 3–4. pp. 166–168, 1924.)—The first note deals with a work of al Maqrīzī (1364–1442), in which he describes a "magnetic fish." This is a hollow iron vessel shaped like a fish, which is magnetised by a lodestone and then floated on water. The second note deals with an argument of al Charaqī (about 1139) relative to the holding capacity of a vessel at different distances from the centre of the earth. [See also Abstract 1233 (1923).] A. A. D.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2352. *Destruction of Carbon Bisulphide by Ultra-violet Rays.* **G. Bruhat** and **Pauthenier.** (Comptes Rendus, 178. pp. 1536–1538, May 5, 1924.)—Light from the mercury arc decomposes carbon bisulphide with liberation of sulphur. The visible spectrum is without action, even on prolonged exposure, and the first ray with appreciable effect has $\lambda = 366\ \mu\mu$. The phenomenon is related to the absorption of the carbon bisulphide, and is being investigated quantitatively. T. H. P.

2353. *The Complexity of the Elements. Part I. Elements of Odd Atomic Number.* **A. S. Russell.** (Phil. Mag. 47. pp. 1121–1140, June, 1924.)—The mass-numbers of elements which are not radio-active are deduced by analogy from the radio-active elements and deductions from the properties of these elements, assuming the disintegration series postulated previously by the author [see Abstract 285 (1924)]. The complexity of the elements appears to vary periodically with the atomic number between 39 and 83, the period being atomic number 16. Of the odd elements the following should be simple: 1, 7, 11, 17, 23, 27, 33, 39, 43, 45, 49, 53, 55, 59, 61, 65, 69, 71, 75, 77, 81, 87, 91; probably also 57, 79, 83. The following should consist of two isotopes: 3, 19, 31, 35, 41, 47, 51, 63, 67, 73, and 89. No conclusion is arrived at with regard to the remaining numbers. The mass numbers belonging to even and odd elements are deduced, and groups of missing mass-numbers calculated. The theoretically deduced mass numbers for the elements are compared with the available experimental data of Aston, and any discrepancies discussed. B. W. C.

2354. *A Paradox in Corrosion.* **U. R. Evans.** (Chem. and Met. Eng. 30. pp. 949–953, June 16, 1924.)—It has been shown that the corrosion of metals in chloride solutions in presence of oxygen is electro-chemical in character, being related to currents flowing between the aerated and non-aerated parts of the surface. The latter or inaccessible places become anodic, and attack is concentrated at these points, thus producing pitting or deep local corrosion [see Abstracts 824 (1917), 237 (1923)]. The currents referred to may be due to the whole aerated area being ennobled by a thin protective film, and thus acting as kathode, or to the "nobler particles" alone of the aerated area acting as kathodes in the first instance. The former view is supported by the observation that a current is set up when one only of two electrodes of the same material (zinc, cadmium, or lead), placed in a divided cell, is aerated, provided that the solution is one that allows of the production of an insoluble film over the aerated surface. On the other hand, in a potassium chloride solution containing acetic acid, where no oxide-film could be produced by aeration, little or no aeration current is obtained with pure lead or cadmium unless the electrodes in each compartment are joined to a nobler metal, copper; contact with the latter greatly increases the current, even where this could be produced without it. The conclusion is drawn, therefore, that current may be produced in both ways. T. H. P.

2355. *Passive Tin.* **R. Steinherz.** (Zeits. Elektrochem. 30. pp. 279–286, June, 1924.)—Previous work on this subject is reviewed, and the results are given of the study of the passivity of tin in sulphuric, hydrochloric, hydrobromic, hydriodic, and hydrofluosilicic acids of various concentrations by means of current-potential measurements. The "critical" potential is found to be a function of the concentration of the acid, and it is shown that the dark coating of the passified metal cannot be regarded as the cause of the passivity. The anion of the acid appears to exert a specific influence on the passivity. Although movement of the metal does tend to render more difficult the attainment of passivity, yet it is possible to make rapidly rotating tin electrodes passive. Both in the active and in the passive condition tin appears to dissolve as a divalent metal. T. H. P.

2356. *Tammann's Limit in the Solubility of Alloys.* **G. Borelius.** (Ann. d. Physik, 74. 3. pp. 216–230, May, 1924.)—Tammann found, for example, that an alloy of gold and silver was not attacked by nitric acid until the silver presented a percentage of 50, and came to the conclusion that the atoms of gold and silver were arranged in regular structure. The author finds that this conclusion is unfounded, and that the observed facts can be equally well explained, at least qualitatively, by a fortuitous distribution of the atoms. A. D.

2357. *Oriented Wedge Theory of Emulsions.* **W. D. Harkins** and **E. B. Keith.** (Science, 59. pp. 463–467, May 23, 1924.)—The criterion is that the molecules in the surface-film are oriented so as to give the maximum lowering of surface energy; then the film of oriented molecules serves to stabilise the droplet [see Abstract 1083 (1917)]. A certain amount of ionisation will occur; the film will be negatively charged; the potential is about − 0·060 volt. Hydrolysis also affects the results. The addition of NaHO reduces this, reduces the size of the drops, and alters the potential to − 0·045 volt. Langmuir attributed the stabilising shape of the surface molecules to the adsorption of OH on the COOH group of oleic acid, lying externally; Harkins, Davies and Clark to the form of molecules of sodium oleate. Recent work has confirmed the latter view; but the shape of the molecules of soap is not the only factor, for we have staggering or bending of molecules in the film, the presence of oil between the hydrocarbon chains, the presence of acid or acid salt, and of oleate ions in the film. An array of facts is collated which lead to a more comprehensive theory of emulsions than has been developed heretofore. This will be presented in connection with a series of papers which will include measurements on cataphoresis, on surface energy, and other factors. A. D.

2358. *Colloid Science and Technics.* **W. Ostwald.** (Zeits. Vereines deutsch. Ing. 68. pp. 481–484, May 17, 1924.)—The scientific basis of the study of colloidal substances, the different types of colloids, the alteration in properties of a substance on subdivision, the physical and chemical behaviour of colloids, and the influence of colloidal changes on technical processes are discussed. T. H. P.

2359. *The Conductivity of Aqueous Perchloric Acid.* **E. Linde.** (Zeits. Elektrochem. 30. pp. 255–259, June, 1924.)—The conductivity of aqueous perchloric acid, plotted against the concentration of $HClO_4$ in the solution, shows a maximum value with 37 per cent. $HClO_4$ at 25° C. No change in direction of the curve is indicated at points corresponding to the hydrates $HClO_4 . H_2O$; $HClO_4 . 2H_2O$; $HClO_4 . 3H_2O$. The ionic concentration J, which is given by $J = \frac{\Lambda}{\Lambda_\infty} . \eta . N$ (where η = viscosity; N = normality of solution) plotted against the concentration, increases regularly until the point $HClO_4 3H_2O$ is reached, then falls off to $HClO_4 . 2H_2O$, and finally rises slowly to $HClO_4 . H_2O$. The curve for the dissociation coefficient $\alpha = \frac{\Lambda}{\Lambda_\infty} . \eta$ shows points of inflection corresponding to the existence of these hydrates. The value of the temperature coefficient for solutions of various strengths is determined between 25° and 50° C. B. W. C.

2360. *Conductivity and Ionisation of Solutions of KI in Nitromethane.* **J. C. Philip** and **H. B. Oakley.** (Chem. Soc., J. 125. pp. 1189–1195, May, 1924.)—Solutions are examined at 0° C., 25°, 40°, 55°, 70°, 85°, and up to the dilution V = 10,000. The degree of ionisation, as measured by the conductivity ratio, decreases steadily with rising temperature, in agreement with what has been found for aqueous salt solutions. The equivalent conductivity at infinite dilution is very nearly proportional to the fluidity *f*, or, exactly, to $f^{0\cdot95}$. The temperature-coefficient of the conductivity increases with the dilution; 0·013 for N/100 and 0·014 to 0·015 for N/800. A. D.

2361. *Diffusion of Molecules and Ions into the Solution of Another Substance and the Retarding Action of this Solution.* **I. D. Götz** and **G. P. Pamfil.** (Zeits. phys. Chem. 109. 3–4. pp. 165–182, 1924.)—The experiments here described were made with the object of ascertaining the relative retarding effects of the solution of a strong electrolyte and of the solvent towards the motion of particles having magnitudes of the same order as ions. To this end measurements were made of the velocities of diffusion of potassium permanganate, ferric chloride, and eosin-blue into aqueous solutions of various concentrations of various salts. The apparatus used was so designed as to eliminate many of the sources of error usual in the measurement of diffusion.

The extent to which the movement of the diffusing substance is retarded is independent of the character of such substance. The velocity of the diffusing substance diminishes *pari passu* with the equivalent conductivity of the dissolved strong electrolyte, so that the decrease in the equivalent conductivity of a dissolved substance with change in its concentration is solely a result of an increase in the frictional resistance of the solution. That being the case, the hydration of the different ions of the dissolved substance must be independent of its concentration, and the molecules of strong electrolytes, even at considerable concentrations, must be completely dissociated. The results obtained are expressed by the equation, $\lambda_c \times r_c = \lambda_\infty \times r_\infty$ = constant, where λ_c represents the equivalent conductivity of a strong electrolyte in aqueous solution of concentration c and r_c, the absolute viscosity of such solution. T. H. P.

2362. *Fatigue of Metals.* **H. F. Moore** and **T. M. Jasper.** (Univ. of Illinois Eng. Exp. Sta., Bull. No. 142 [86 pp.], May 26, 1924.)—Records the progress of the investigation, organised in 1919; constitutes the third report, and contains a modification and extension of the theory that fatigue failures in metals start from slip planes within the crystalline grains. In the case of wrought ferrous metals, retests of specimens which have withstood millions of cycles of stress without failure, showed an increase of resistance to further repeated stress, thus giving additional evidence of the existence of an endurance limit. Repeated stress at or below the original endurance limit raises the limit, whereas a few cycles above this limit lowers it. A specimen injured by such overstress may have its strength partly restored by polishing its surface or by repeated stress below the endurance limit. The static strength is also increased by the same means. Under cycles of completely reversed axial stress, the endurance limits obtained averaged **64** per cent. of those obtained under cycles of reversed flexural stress. The effect of the direction of rolling on the endurance limit is similar to that on the static tensile strength. The endurance limit and static strength of very low carbon steel are raised appreciably by water quenching from 1500° F. The endurance limit for cycles of reversed shearing stress is about **53** per cent. of that for cycles of reversed flexure. For flexural stress and for axial tensile stress the equation $S_r = S_{-1}(r + 3)/2$ gives safe values for endurance under cycles of partially reversed stress or of stress varying from zero to a maximum. In the equation S_r is the tensile unit stress at the endurance limit for the range of stress represented by r; S_{-1} is the same for completely reversed stress; and r is the ratio of minimum to maximum for a cycle of stress. For shearing stress the endurance limit for cycles varying from zero to a maximum stress is nearly twice that for cycles of completely reversed stress. Preliminary tests on specimens of annealed non-ferrous metals have not yet determined that these have an endurance limit; if such a limit exists it may be necessary to carry fatigue tests to hundreds of millions of cycles of stress in order to determine it. It seems probable that short time tests for determining endurance limit by rise of temperature of a specimen subjected to cycles of reversed stress, or from the load-deflection diagram for a rotating beam, determines the beginning of appreciable slip within the crystalline grains rather than the beginning of fatigue fracture. These short time tests seem safe for wrought ferrous metals with a Brinell number less than **375** and reasonably free from inclusions or flaws, but cannot be considered safe for cast or for non-ferrous metals. [See Abstract 1195B (1923).] C. O. B.

2363. *The Alteration of the Vibration (Acoustic) Figures of Rolled Plates after Recrystallisation.* **E. Schröder** and **G. Tammann.** (Zeits. f. Metallkunde, **16.** pp. 201–206, June, **1924.**)—The present investigation is intended to supplement the very scanty means of testing the elastic behaviour of worked metals, and for this purpose acoustic methods have been examined on analogy with ceramic testing. The historical vibration figures of Chladni are briefly described and applied to the cases in hand with excellent results. Circular discs of the metals copper, zinc, and aluminium bronze have been used in the experiments before and after recrystallisation, and the various Chladni figures obtained. Experimental details are included with thirteen diagrams, from which important conclusions as to the elastic behaviour of these metals during the various stages of working are drawn. The method promises to be of great utility. H. H. Ho.

2364. *The Use of Boron in Cast Copper.* **Weintraub.** (Soc. Franç. Élect., Bull. **4.** pp. 229–230, March, **1924.**)—A reply to criticisms made by Guillet [see Abstract 1560 (1924)] on the use of boron for deoxidising copper. He suggests that sub-oxide of boron is preferable to the carbide, though, owing to price, the latter is frequently employed. The product obtained by the reduction of sodium borate and aluminium is quite unsuitable. J. L. H.

2365. *Metallography in Polarised Light.* **L. C. Glaser.** (Zeits. techn. Physik, 5. 6. pp. 253–260, 1924.)—The various methods of employing polarised light for metallography are described and discussed. The methods available are :—

Qualitative.—(1) Investigations with crossed Nicols. (2) Investigations with crossed Nicols and retardation plate or wedge.

Quantitative.—(1) The method involving the use of the Savart plate. (2) A photometer method due to the author.

The details of the various optical arrangements are given, and coloured photographs of phosphor-bronze, phosphor-tin alloys, taken in polarised light, are shown. By means of the photometric method it is possible to determine the reflection constants and the anisotropic properties of the various constituents of an alloy. F. J. B.

2366. *Electrical Steel Testing.* **B. Kjerrman.** (Zeits. Vereines. deutsch. Ing. 68. pp. 629–631, June 14, 1914.)—The determination of the constituents of iron and steel and their influence upon the ultimate properties of the metal by electrical means is described. The method, due to B. D. Enlund, renders it possible to determine the other elements present in steel, especially carbon and silicon, and to classify the material according to its mechanical properties by means of measurements of electrical resistance. By means of a sample rod, cast into a mould or rolled from a test piece, the progress of the refining of steel can be followed. The relationship between the composition, resistance and mechanical properties is illustrated by examples. A method for the determination of the transition points of steel is described, in which the transition points are determined by changes in resistance. The operation is carried out in an atmosphere of inert gas, and has the advantage of being rapidly completed. F. J. B.

2367. *The Photochemical Decomposition of Monochlor- and Monobrom-acetic Acid and the Einstein Law.* **E. Rudberg.** (Zeits. f. Physik, 24. 3–4. pp. 247–263, 1924.)—In this paper experiments are described which demonstrate the relation between the chemical reactions and the number of absorbed quanta when monochlor- and monobrom-acetic acid are decomposed in solutions in water under the action of ultra-violet light. The photometric decomposition of monochlor-acetic acid takes place in light of $253 \cdot 6\ m\mu$, according to the Einstein law. The limit of efficacious rays on the side of greater wave-lengths lies between 266 and 313 $m\mu$. The decomposition of monobrom-acetic acid does not obey the equivalence law under the same conditions. The light begins to be active in this case between 266 and 313 $m\mu$. The molar extinction coefficient for $253 \cdot 6\ m\mu$ is about 125 times greater than with chlor-acetic acid. A. E. G.

2368. *Potential Difference between Air and a Solution.* **A. Frumkin.** (Zeits. phys. Chem. 109. 1–2. pp. 34–48, 1924.)—The production of potential-difference between air and a solution of an inorganic electrolyte is determined by the adsorption of anions. The adsorbability of anions is greater the smaller their affinity for water (their adsorption-energy). Acids take a greater charge than the corresponding salts. The results of electrometric measurements agree completely with those of surface-tension measurements in aqueous solutions. The salts which give the greatest charge on the water-surface raise the surface-tension least, and crowd most into the superficial layer. A. D.

2369. *The Standardisation of the Sign of Electric Potential.* **A. W. Porter.** (Faraday Soc., Trans. 19. pp. 703–704, March, 1924.)—Suggestions to avoid confusion.

2370. *The Free-Energy and Heat-Content of Arsenious Trioxide and the Reduction-Potential of Arsenic.* **R. Schumann.** (Am. Chem. Soc., J. 46. pp. 1444–1449, June, 1924.)—The e.m.f. of the cell

$$As(s) + As_2O_3(s)/HClO_4(0{\cdot}22 - 0{\cdot}94M)/H_2(1 \text{ atmosphere}),$$

measured at 25° and 45° C., is found to be $-0{\cdot}2340$ and $-0{\cdot}2250$ volt respectively. From these values the free-energy of arsenious trioxide (octahedral), referred to crystalline metallic arsenic, is found to be $-137{,}300$ cal. The heat-content is found to be $-153{,}800$ cal. It is concluded that the arsenic is in solution as $HAsO_2$, and the molal electrode or reduction-potential calculated for the reaction

$$As + 2H_2O + 3\oplus = HAsO_2 + 3H^+$$

is found to be $-0{\cdot}2375$ volt. B. W. C.

2371. *Electromotive Properties of Glasses.* **H. Schiller.** (Ann. d. Physik, 74. 2. pp. 105–135, May, 1924.)—In strong fields counter e.m.f.'s are developed in glasses, of the same order as the external field. Investigation of the behaviour of glass plates in solutions as simple electrodes and as mixed electrodes. Every kind of glass has its characteristic solution pressure when acting as an electrode. A. D.

2372. *The Effect of Hydrogen Pressure on the e.m.f. of a Hydrogen Calomel Cell. Part II. The Fugacity of Hydrogen and Hydrogen Ion at Pressures up to* 1000 *Atmospheres.* **W. R. Hainsworth, H. J. Rowley** and **D. A. MacInnes.** (Am. Chem. Soc., J. 46. pp. 1437–1443, June, 1924.)—The apparatus described previously [see Abstract 2178 (1922)] has been improved and modified. The effect of hydrogen pressure on the e.m.f. of the cell H_2O/n HCl, HgCl/Hg has been measured accurately up to 1000 atmospheres, the pressure being measured by a special piston gauge instead of a hydrostatic gauge, which gives unreliable figures. The observations are discussed from a thermodynamical standpoint, and it is shown that the apparent "fugacity" of the hydrogen is 100 per cent. higher than the pressure; three-fourths of this is due to the deviation of hydrogen from the laws for a perfect gas; one-fourth to a decrease in the relative activity of the hydrogen ion, due to the solubility of hydrogen in the liquid at the high pressures involved. B. W. C.

2373. *The Single Potential of Arsenic and its Power of Replacing Other Metals in Solutions.* **L. Kahlenberg** and **J. V. Steinle.** (Am. Electrochem. Soc., Trans. 44. pp. 493–516; Disc., 517–518, 1923.)—In determining the single potentials of arsenic in different solutions, aqueous and organic, the authors find arsenic strips sawn from lumps to be the most reliable, though brittle, electrodes; the strips are fixed between brass clamps which are coated with melted paraffin. Compressed sticks of the powdered arsenic and arsenic mirrors (from Marsh test) could also be used, but the latter peeled off from the glass walls; electrodes of powdered arsenic pasted on metal foil with the aid of binders were not satisfactory. The single potential of arsenic is found to be 0·55 volts. In the electro-chemical series arsenic would thus lie between Bi and Cu; but the nature of the electrolyte is a factor of importance. In the displacement experiments arsenic (massive or powdered) is placed in solutions, in water or organic solvents, of various salts, or other metals are put in solutions of arsenic salts. Arsenic is not displaced by Au, Pt, Pd, Mo, whilst Cr, Fe, Co, Ni do not replace arsenic. But the nature of the reaction cannot be predicted from the electro-chemical series; the replacing power of metals seems to be a highly specific property of the metal and of the liquid in which it is immersed, and the toxicity of solutions of arsenic compounds seems not to depend upon the concentration of arsenic ions.—In the *Discussion*, **W. Blum** remarked that the potential relations indicate a measure of the tendency of the metal to pass into (or out of) solution. Whether such potentials could be expressed in terms of ions was still uncertain owing to our limited information on ionisation in non-aqueous solutions and in fused salts. H. B.

2374. *Anomalous Mobility of Electrolytic Ions.* **H. Schmick.** (Zeits. f. Physik, 24. 1. pp. 56–64, 1924.)—Calculation of the maximum Born dipolar effect [Abstract 1029 (1920)] in a given field of an elementary ion. Anomalous mobility can be explained if we assume that the radius of action of an ionic charge increases when the true radius of the ion diminishes. A. D.

2375. *Influence of Light- and Röntgen-Rays on Anodic Polarised Platinum Electrodes.* **G. Grube** and **L. Baumeister.** (Zeits. Elektrochem. 30. pp. 322–332, July, 1924.)—Platinised platinum electrodes immersed in 2N-sulphuric acid and coated with oxides of platinum by treatment with gaseous oxygen or by anodic polarisation exhibit a fall of potential in the light, the extent of such fall increasing with the height of the potential prior to the illumination. Smooth platinum electrodes which have been covered superficially with oxides by anodic treatment with direct and superposed alternating current exhibit, when illuminated, a two-sided Becquerel effect, a fall of the potential occurring immediately the illumination begins, and a more pronounced rise subsequently. When the illumination is repeated, the positive effect vanishes, and only the negative effect is observed. The influence of Röntgen-rays on the potential of oxidised platinum electrodes is similar to that of ordinary light, and the potential of the oxygen electrode is affected by an alternating current in the same way as by light. These results are discussed in their relation to Baur's theory of photolysis [Abstracts 1448 (1919), 233 (1922), 1705 (1923)]. T. H. P.

2376. *The Effect of Temperature on Overvoltage.* **M. Knobel** and **D. B. Joy.** (Am. Electrochem. Soc., Trans. 44. pp. 443–450; Disc., 450, 1923.)—The hydrogen overvoltage on kathodes of silver, copper, nickel, lead, and smooth and platinised platinum are measured at various temperatures from 0° to 75° C. The possible sources of error in previous measurements made by various investigators are pointed out, and a method described by which reproducible results can be obtained. The electromotive force of the cell $H_2/2n\text{-}H_2SO_4/Hg_2SO_4/Hg$ was measured at temperatures from 0°–90° C., and the overvoltage measured against this at various current-densities. The overvoltage decreases directly with the temperature in almost every case; the slope of the straight lines obtained by plotting the results is found to be practically the same for silver, copper, nickel and lead. In the *Discussion*, it is suggested that the slope of these lines will indicate whether a hydride or occluded hydrogen is concerned in overvoltage. B. W. C.

2377. *Crystalline Form of Electro-deposited Metals.* **W. Blum** and **H. S. Rawdon.** (Am. Electrochem. Soc., Trans. 44. pp. 397–419; Disc., 419–425, 1923.)—A simple theory of the mechanism of crystal formation in electro-deposition is outlined. The kathode discharge of metal ions and the formation of crystals are regarded as constituting one and the same process, and the point at which any given ion is discharged is that where the lowest discharge potential is required. Such potential is a function both of the solution pressure of the metal and of the "effective" metal ion concentration adjacent to it.

The single potential and solution pressure of a metal are the resultants of (1) the "primary single potential," which is defined in terms of the solution pressure of a single unoriented atom, and (2) the "orientation potential," which is a measure of the diminution in solution pressure and corresponding algebraic increase in single potential caused by the arrangement or orientation of the adjacent metal atoms. A higher potential is required to discharge an ion in a position unrelated to those of previously discharged atoms (that is, to form a nucleus) than upon an existing crystal, and, similarly, a higher potential is required to discharge an ion upon a small crystal than upon a large crystal.

Typical structures of electro-deposits are classified into three major groups, according as almost all, only some, or none of the initial nuclei continue to grow, numerous varieties existing in each of these groups. The factors determining the character of the crystals are discussed, and it is shown that the direction of the charge produced by any alteration in the operating conditions may be predicted.

In the *Discussion*, **E. C. Bain** questions the assumption that rolled or burnished kathodes are amorphous, since the most severely worked and unannealed metal obtainable showed almost perfect crystalline character under X-ray examination. **F. C. Mathers** suggests that the theory advanced does not take the effect of colloids sufficiently into account. **L. Kahlenberg** states that the density of the deposit is not merely a question of the concentration of the silver ions as deduced from potential measurements, but depends on the nature of the electrolyte. T. H. P.

2378. *The Deposition of Iron containing Carbon by the Electrolysis of Iron Oxalate.* **W. Sontag.** (Zeits. Elektrochem. 30. pp. 333–344, July, 1924.)—The iron oxalate solution, prepared under stated conditions from ferrous sulphate and ammonium oxalate, is electrolysed in the presence of a diaphragm. Pure iron is deposited at first, the liquid around the kathode becoming strongly ammoniacal, and a portion of the iron being precipitated as hydroxide. Subsequently the iron deposited may contain 3 or 4 % of carbon in an amorphous form. At the same time glyoxalic, glycollic and succinic acids can be detected in the liquid round the kathode, representing the products of electrolytic reduction of oxalic acid. The gases evolved contain carbon dioxide and a little carbon monoxide. Electrolytic experiments with succinic acid show that it is the decomposition of one of the carboxyl groups of this acid into carbon monoxide, and subsequent breaking down of this gas according to the equation $2CO = C + CO_2$, which accounts for the association of carbon with the deposited iron. According to this explanation, propionic and adipic acids might also be expected to be present, but probably in amounts too small to be detected. The amount of succinic acid formed is considerably less if no diaphragm is used. Experiments with ammonium tartrate solution also yield succinic acid, and probably carbon associated with the deposited iron would result in this case also. It is shown that it is possible to produce succinic acid from glycollic acid by reduction with zinc dust, as well as by electrolytic reduction. B. W. C.

2379. *Electrolytically Chromium-plated Metals.* **E. Liebreich.** (Zeits. f. Metallkunde, 16. pp. 175–177; Disc., pp. 178–179, May, 1924.) —A recommendation of chromium-plating [Abstract 586B (1923)]. Flat-irons, parts of electric-welding machines, etc., are much less liable to oxidation when so plated. The hardness of chromium is valuable in chromium-plated steel dies, and the plated metal resists chemicals better than when nickel-plated. The chromium deposit is very fine-grained when there are plenty of germs present, and when conditions (partial deposition of chromium hydroxide) interfere with the growth of the crystals; deposits are generally fine-grained where in contact with the kathode, and become coarser in thicker layers. In reply to **Füchsel, Nowack** and **Koch,** the author doubted that chromium deposits could prevent the corrosion of the sheet metal of coke cases by the sulphurous acid in the coke; the process was quicker and not more expensive than nickel-plating; aluminium did not appear suitable for chromium-plating. Bright chromium deposits could not be made more than 0·1 mm. in thickness. Thicker deposits tended to peel off; it would be difficult to plate the internal walls of spheres, but that was also the case with nickel. H. B.

2380. *Chromium-plating of Steel with Chromium Anodes.* **K. W. Schwartz** (Am. Electrochem. Soc., Trans. 44. pp. 451–463; Disc., 463–466, 1923.)—The author studies the process of G. J. Sargent [Abstract 1640 (1921)] and obtains good adherent deposits using solutions containing 3 gr./litre of chromium sulphate and 200 to 300 gr. of chromic acid, the kathode density ranging from 9·3 to 16 amp./sq. dm. The chromium anodes did not become passive, and are cheaper than platinum and better than lead. The simultaneous evolution of hydrogen is essential to the formation of good deposits on iron and steel, which then resists also fumes of nitric acid, hydrogen sulphide and ammonia, and is not attacked by molten tin, zinc and brass. The steel temper is not lost during the chromium-plating.—**H. K. Richardson** and **C. G. Fink** supported the statements of the author. **S. E. Sheppard** and **A. Ballard** had found Liebreich's process good, but used 5·3 volts and more instead of 2·5. **W. Blum** mentioned that steel, coated with 0·013 mm. of chromium cut so as to expose an edge, rusted in distilled water in twelve hours, whilst the zinc-coated steel did not rust for several days under the same conditions. H. B.